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Pritchard, A.

The natural history of
animalcules

London, 1834

MBL/WHOI



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PRITCHARD'S ACHROMATIC MICROSCOPE.
(Aplanatic Engiscope.)



Fig. 4.



Fig. 5.

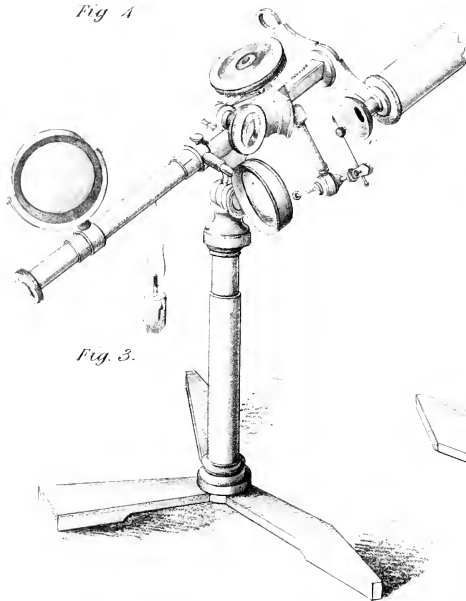


Fig. 3.

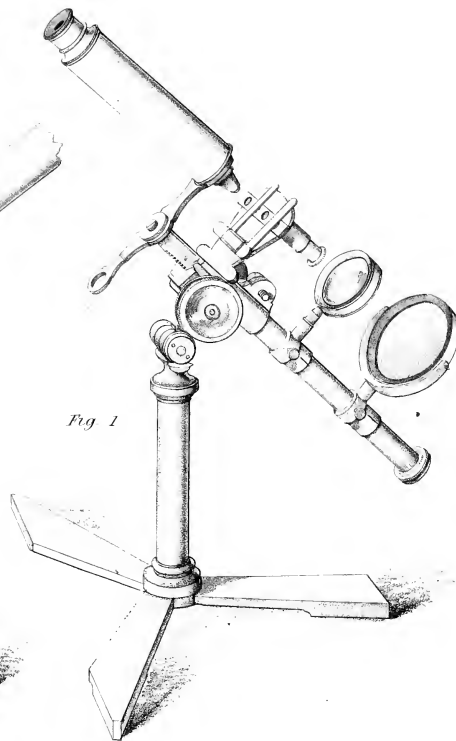


Fig. 1.

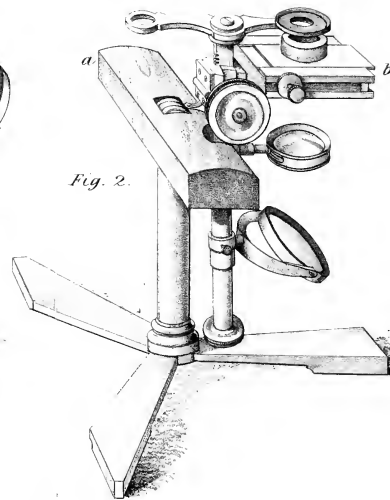


Fig. 2.

Fig. 1 exhibits the instrument in the most convenient position for viewing transparent objects by reflected light — the stops and condenser under the stage should be removed for some objects — For Tests with direct light the instrument can be turned round. — Fig. 2 shows the position for dissecting. a. the new rest for supporting the hands, which possesses many advantages over the methods hitherto adopted. — b. a moveable stage. — Fig. 4. an Eyepiece. — Fig. 5 Apparatus for holding a bottle to view aquatic objects, and the circulation in Plants, &c.



Fig. 4.

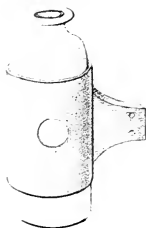


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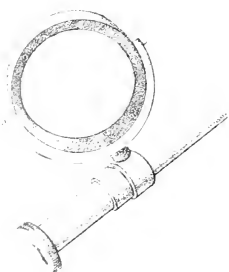


Fig. 3.

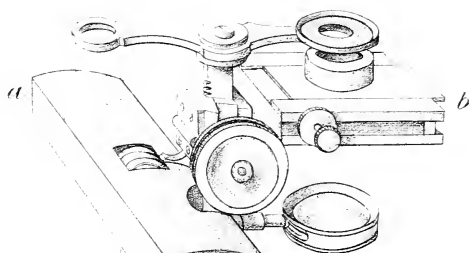


Fig. 2.

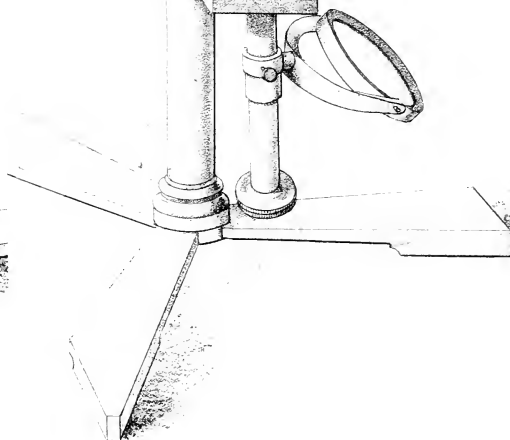


Fig. 1 exhibits *lens and condenser under the stage should be removed for some objects* — *a.* the new rest for supporting the hands, which possesses many *apparatus for holding a bottle to view aquatic objects,*

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THE
NATURAL HISTORY
OF
ANIMALCULES:

CONTAINING
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INFUSORIA;

WITH
INSTRUCTIONS FOR PROCURING AND VIEWING THEM,
&c. &c. &c.

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ON STEEL.

By ANDREW PRITCHARD, Esq.

AUTHOR OF THE "MICROSCOPIC CABINET."

LONDON :
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1834

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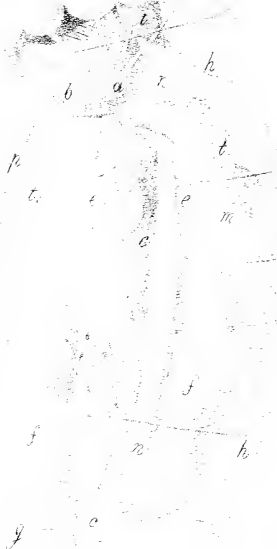
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ERRATA.

Page 141, No. 340, for "Figure 323," read "No. 324."

Page 135, No. 309, for "cunex," read "cimex."

PREFACE.

Few branches of science hold out stronger inducements for their study than the Natural History of Animalcules, which, while it is pursued with great facility, affords, at the same time, by reason of the singular forms and diverting habits of these creatures, a degree of interest scarcely to be exceeded. For this reason, and to reply to the many inquiries addressed to me, such as—Where can you refer me to a description of animalcules?—What magnifying powers are the best to view them with?—What are their comparative sizes?—I have found a very curious creature of such and such a form ; is it known?—Where can I obtain drawings of such as are known? &c. &c.—I have ventured to take a general survey of the subject, and the more willingly, because at present no similar work exists, unless it be that of Adams, published in 1787, which contains only a very slight account of the external characters of such as were known in his time, without giving any admeasurement of their size, or sufficient figures to render it generally useful ; while its price is such as to place it beyond the reach of many persons.

The materials I have employed in constructing this little treatise are derived principally from my own practical observations, although I am free to acknowledge that I am greatly indebted to Müller and Ehrenberg, especially for the arrangement of them : and as this department of zoology is mainly dependent on the plates for affording any thing like a comprehensive view of it, immense pains have been taken to give the numerous drawings as nearly as possible the appearance of what they are intended to represent, when viewed under the microscope. Where the details, as in many instances, cannot be admitted, still, on the whole, a great similarity is preserved. Mr. Cleghorn has shewn much talent in the Engravings, some of which, I may safely say, in point of execution can hardly be excelled.

ANDREW PRITCHARD.

18, PICKET-STREET, LONDON.

BOOK I.

OF the multiplicity of objects, which the almost incredible powers of the Microscope have brought under our observation and scrutiny, perhaps that class of animated beings denominated *Animalcules* may be considered the most remarkable. The bare knowledge that there are myriads of atoms (and in the scale of living creatures we can call them nothing else) existing in a single drop of water, recreating and executing all their various functions and evolutions with as much rapidity and apparent facility as if the range afforded them were as boundless as the ocean, must carry with it an intensity of interest to the mind of every human being; of every one, at least, who is at all accustomed to meditate on the perfections of Nature, and to recognize and adore the hand that guides her through all the vast variety of her stupendous operations. As our acquaintance with the minute portions of the creation is exclusively dependent upon the properties of the Microscope, every refinement of this interesting and valuable instrument must necessarily contribute something to our stock of knowledge on the subject; and indeed it is entirely owing to the very great perfection which it has now acquired, that a fresh spirit of research is widely extending itself,—a

research into those recondite truths which may lead not merely to the gratification of our curiosity but to some of the most important and scientific results.

For a lapse of years, after the publication of Müller's "Animalia Infusoria," in 1786, this branch of Natural History remained stationary, if not utterly disregarded ; nor, indeed, did it, until very recently, assume what may be termed a regular form, constructed of materials the most precious of all, viz. truths brought together by practical and diligent investigation. To Dr. Ehrenberg's late observations, although they apply to such only as belong strictly to the Phytozoa*, we are greatly indebted. Lamarck, too, in 1815, and Cuvier, in 1817, made considerable advances in classification : but then, as the systems of these two last-mentioned Naturalists were not founded upon a rigid inspection of the Animalcules themselves, I have deemed it advisable, in the general arrangement of this little Treatise, to abide by those of Müller and Ehrenberg.

The term Animalcule, which implies nothing more than the *diminutive* of animal, has been commonly used to denote those living creatures inhabiting fluids, which are too minute to be scanned, or even seen by the naked eye : such, for instance, as those produced in inconceivable numbers from infusions of animal and vegetable matter : it comprehends as well such as are found in, and are peculiar to, the bodies of larger animals :

* Book III.

this latter class, however, does not fall within the province of this work.

In the variety of systems that have been put forth respecting these extraordinary creatures, the main characteristics of each have referred either to a difference in their size, or to the general appearance of their external forms: the present design, however, is not to investigate the value of these. Until the introduction of vegetable colouring matter into the fluid, which supplies them with food,—an experiment that has been attended with very successful results,—these creatures were commonly supposed to be entirely devoid of internal organization, and to be nourished by the simple process of cuticular absorption. By the application of coloured substances, which, moreover, have been found to invigorate rather than to depress the animalcule, and to maintain it in the full exercise of all its functions, this erroneous notion is set at rest, and an internal structure is discerned in some, equal, if not surpassing that of many of the larger invertebrated animals, and comprising a muscular, nervous, and, in all probability, vascular system; all wonderfully contrived for the performance of their respective offices.

The most obvious portion of their internal structure is undoubtedly that connected with the digestive functions; and hence it is that Ehrenberg has selected this as the leading feature of his arrangement, denominating his two grand divisions of the Phytozoa, Polygastrica and Rotatoria; the former of which includes such as are pos-

essed of several distinct stomachs or digestivesacs; and the latter such as have true alimentary canals and rotatory organs provided with a number of cilia aptly disposed for promoting the objects of life : these two grand divisions of the Phytozoa are afterwards subdivided into families and other minor branches, as exemplified in Book III. The cilia, in their different combinations, supply the means of locomotion, propelling the creature in many cases with great rapidity through the water : they are apparently stiff, like eye-lashes ; and from Dr. E.'s description of some of the larger ones, they issue from bulbous substances at their bases, and being acted upon by muscular fibres are capable of being moved to and fro in particular directions, so as to occasion a current of the fluid to flow towards the mouth of the animalcule, by which it is furnished with fresh water, or food. They are sometimes disposed, as before stated, round certain organs of a circular form, which, on account of their peculiar vibrations giving the appearance of a rotatory action, are termed rotatory organs ; (see page 144). A second curious feature in the construction of some of these minute creatures are the *setæ*, or bristles, attached to the surface of their bodies : these short moveable hairs in all probability act as fins, and contribute greatly to their means of motion. The third feature are the *uncini*, or hooks, setaceous appendages curved at their extremities, and serving the creature to attach itself to any object it chooses. A fourth are the *styli*, jointed at their bases, and differing from the cilia in respect of their being

unable to effect a rotatory motion : these, however, are more flexible, and have more play than the *setæ*. Independently of these peculiarities, some animalcules possess the extraordinary faculty of thrusting out, or elongating, portions of their bodies at various points, which, assuming the appearance either of legs or fins, are termed *variable processes*, and enable the creature to walk or swim. Some remarkable examples of this are given at Nos. 22 and 236. With one more observation respecting the caudal appendages of animalcules—viz. that in many cases they have important functions to fulfil—I shall close this cursory view of the external structure of these little beings, remarking, at the same time, that the power and goodness of the Almighty are as clearly evinced by the humble but efficient means afforded these living atoms of pervading the narrow limits of their sphere of action, to provide for their wants and pleasures, as by the more exalted gifts He has graciously bestowed upon the intellectual part of the creation, whose occupations are so manifold, and whose views are as boundless as their thoughts. For an account of the internal organization, the reader is referred to Book III. I shall next proceed to state the particular method by which a more intimate knowledge of this interesting subject may be acquired.

It was a favourite hypothesis with Naturalists, some years ago, that the class of animalcules under consideration was entirely nourished by cutaneous absorption, and that no suitable organs for transmitting and digesting food were discoverable. Baron Gleichen was the

first who brought the truth of this theory to the test ; for having tinged some water containing animalcules with carmine, he found on the second day that only some distinct cavities in the interior of their bodies were filled with the colouring matter, evidently demonstrating the existence of an alimentary structure : here, however, he left the subject, and it is to Dr. Ehrenberg's further investigation of it that we are indebted for an accurate description of their different forms, as given in Book III. In more recent experiments it has been found advisable to employ vegetable colouring substances in their pure state ; such, for instance, as sap green and indigo, which, together with the valuable acquisition of an excellent instrument, enabled the Doctor to contribute much to our previously imperfect knowledge of this branch of Natural History. Before I explain the manner of *Viewing these creatures* under the Microscope, I shall venture a few remarks on *the Method of Procuring them*. In the selection of vegetable substances for infusions, such as stalks, leaves, flowers, seeds of plants, &c. care must be taken that there be no admixture of quinine in them, or the intention will be frustrated. Immerse these, whatever they may be, for a few days, in some clear water, when, if the vessels which contain them be not agitated, a thin pellicle or film will be discerned on the surface, which, under the microscope, will be seen to be inhabited by several descriptions of animalcules : the first produce are commonly those of the simplest kind, such as the Monads. In a few days more, their numbers will increase to such

an amazing extent, that it would be utterly impossible to compute those in a single drop of the fluid. After this, again, they will begin to diminish in numbers, and I have generally observed them supplanted by others of a larger species and more perfect organization; such as the *Cyclidia*, *Paramesia*, *Kolpodæ*, &c. It is worthy of remark here, however, that in their production they do not pursue any regular order, even in similar infusions. If the vessel be large, and the circumstances under which it is placed sufficiently favourable, a still higher description of animalcules will succeed, viz. the *Vorticella*, and, lastly, the *Brachioni*; and thus a single infusion will repay for the little trouble of making it, with a great variety of species. Water in which flour has been steeped will be found to abound also with animalcules: and it is remarked by G. Leach, Esq. that the leaden troughs, constantly appropriated for birds to drink out of, contain several descriptions of them, and more especially those of the wheel genus. In ponds, too, especially in the shallow parts, near their edges, and in the immediate vicinity of water-plants, prodigious quantities of all kinds may be easily procured; so that possessing as we do such myriads of them all around us, that they impregnate almost every thing that we eat and drink, touch and breathe, an anxiety to know more about them, and the effects they produce, cannot but be regarded as rational and laudable.

It would be exceedingly difficult, if not impossible, to

convey to the mind, by any other representation than drawings, a correct idea of the varied forms of these singular beings, for in many instances they appear to have no similarity whatever with any other class of objects in nature ; I must refer the reader, therefore, to the Plates at the commencement of this work, premising, at the same time, that no pains have been spared in the attempt to produce in them faithful resemblances of these extremely delicate creatures, as they appear under the Microscope. I would not imply by this that the great variety there exhibited are delineated in the full detail of all their curious structures, although in some specimens this has actually been effected : to do it in all would constitute an undertaking far too considerable and expensive to meet the present design ; suffice it, therefore, if enough be accomplished to facilitate our further research, and to exhibit on the whole by far the most complete collection, and one the nearest approaching to truth, of any that has yet been presented to the public. By a careful inspection of the Drawings, it will be noticed that some animalcules resemble spheres, others are egg-shaped ; others again represent fruits of various kinds ; eels, serpents, and many of the invertebrated animals ; funnels, tops, cylinders, pitchers, wheels, flasks, &c. &c. ; all of which are found to possess their own particular habits, and to pursue a course of life best adapted to their peculiar constructions : thus, for instance, while some move through the water with the

greatest imaginable rapidity, darting, leaping, or swimming, others merely creep or glide along ; and many are altogether so passive that it requires long and patient observation to discover any of their movements at all. One description are perceptibly soft, and yield easily to the touch ; another are covered with a delicate shell or horn-like coat. Of the latter order there are different degrees of density, as in the *Volvox*, *Gonium*, &c. where the envelope is comparatively thick ; and where, strange to say, the internal substance separates by the mode of propagation into several portions, forming so many distinct young ones, which at their birth burst the envelope, and the parent becomes entirely dissipated. In others of this order the shell is merely a plate covering the body, resembling that of the tortoise : sometimes it includes the body, so as to leave only two small apertures at the extremities, and at others it is bivalve, and encloses the creature like that of the oyster or muscle.

A reference to the Plates, also, will convey a pretty accurate notion of the extraordinary methods of propagation with animalcules. All vertebrated animals are either oviparous or viviparous, which terms sufficiently designate their modes of production : but it is not so with animalcules ; for, in addition to these two methods—

1. Animalcules propagate by a spontaneous scissure, or division of their bodies into two or more portions, each one forming a new creature, which, on its arrival at maturity, pursues the same course. These divisions take

place in some genera symmetrically, as in the *Gonia*, &c. ; in others, by transverse, longitudinal, or diagonal sections. In these latter cases the produce have forms differently proportioned from those of the creatures from which they spring ; for instance, figure 160 represents the young of 159, engendered by a transverse division : this circumstance, we may observe, renders it sometimes difficult to determine the species. 2. They propagate, in the manner before mentioned of the *Volvox*, and some other genera, by a distribution of the internal substance of the parent into a proportionate number of young ones, all of which at their birth issue forth, and leave behind them nothing but the envelope, soon to be dissolved. 3. They are produced from germs, shooting forth from the parent's sides, as represented by fig. 218, &c. 4. From spawn, which, in the act of being shed, carries along with it a portion of the parent animalcule, as shewn by figure 80.

With respect to the mode of viewing animalcules under the Microscope ; I would direct that they be placed in what are termed aquatic live-boxes (described in the "Microscopic Cabinet"), or on a slip of glass, in which case they should be covered with a thin plate of mica, which will have the effect of preventing the small quantity of water put with them from evaporating, and of rendering the surface perfectly plane for the purpose of observation : an additional advantage, however, will be obtained by making use of my Aplanatic Engiscope, (or

that of Dr. Goring), which is easily arranged to shew these creatures and their domestic habits in the phials they are kept, adhering, as many of them will, to its sides. Although no English work on this subject has previously given any admeasurement of the sizes of the different species, yet as I conceive it to be a matter of some importance, I shall point out the method I have pursued in accomplishing it. Thus; a system of graduation is easily formed on the aquatic live-boxes, or slips of glass, by means of cross-lines intersecting each other at right angles; and under a series of these lines, say 1-500th of an inch apart, an animalcule may be so examined as to afford a very accurate estimate of its dimensions: for instance, suppose it to occupy one-half the interval between two of these lines, then it is clear that the creature measures 1-1000th of an inch: and if it occupy two divisions, compute it at 1-250th of an inch in length. In this manner, with a little practice, and with the aid of a few micrometers of different grades, the intention will be readily effected.

Having selected and placed the object for examination on the stage of your microscope, the next consideration will be how to regulate the illumination, and to select a suitable magnifying power. These points must be carefully attended to, for on them, even with the best instruments, much of the beauty and effect will depend. The most intense and best description of light is to be derived from either a sperm or wax candle, or from what

is perhaps on the whole most convenient, the common Argand lamp. Concentrate this light on the object with a proper condensing lens, taking care at the same time to reduce the quantity, if necessary, by means of diaphragms or stops* placed under the stage : these should be rendered capable of adjustment as to distance from the object, &c. so as to transmit only a cone of rays of the proper dimensions.

A magnifying power of about 100 to 500 will be found to be sufficient for most purposes ; although in an inspection of the Monads, and some minute portions of other objects, a stronger one will doubtless be required. I do not think, however, that any advantage will be gained from powers exceeding 800, as it is of far more importance to obtain a deep penetration and perfect definition than an excess of amplification. Apply in the outset, therefore, a low power, say 100, and if on trial it prove insufficient, double it, and proceed onwards until you are satisfied as to the result ; taking it as a general rule, *never to increase the power beyond what is absolutely requisite*. As the expression, magnifying power, has reference to some standard or other for sight, it is necessary that I should inform the reader of the one I have adopted here ; it is the decimal one, presuming that an object is always viewed without a magnifier under the

* See “ Microscopic Illustrations,” and “ Cabinet,” for further instructions.

angle subtended by it at ten inches from the eye : thus a single lens, which requires the object to be distant from it one inch (*i. e.* of one inch focus), will magnify ten times in length and breadth, and 100 times in surface : and with respect to a system of lenses, arranged as in the compound Microscope, it will be easy enough to estimate their combined power, by first of all referring it to the relative power of a single lens, and then expressing it according to the scale just mentioned. Thus, if an Engiscope were equivalent to a single lens of 1-10th of an inch focus, we should call the power 100 : if 1-20th, 200 : 1-30th, 300 : &c. &c., always implying *linear* measure, unless it be otherwise stated. The area or superficial magnifying power is obtained by simply multiplying the *linear* measure into itself.

The Achromatic Engiscope has indisputably prodigious advantages over any other description of Microscope, and particularly that of being equally applicable to a review of many other classes of objects ; this is especially a property in the one I have recently constructed. It affords a luxuriant field of view, and is managed with great facility. If this, however, cannot be obtained, a good Doublet, well put together, possesses sufficient penetration, and a definition scarcely surpassed by any other instrument. The estimable qualities in these magnifiers are, that they produce a clear and well-defined outline distance between the object and the anterior lens, and an uniformly colourless, and not a dingy

yellow, field of view. Again, if a good Doublet cannot be procured, single lenses, suitably mounted, as in the new Vertical Microscope, display animalcules exceedingly well; and, when skilfully managed, will afford the possessor many an interesting exhibition, will beguile many a tedious hour, and store his mind with some useful truths.

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BOOK II.

GENUS I.

MONADS.

[IN the following descriptions, the first name is that given by F. O. Muller : this, when followed by a star (*), or another with the letter E. in parentheses, denotes the generic name of the same creature, given by Dr. Ehrenberg, the organic characters of which will be found in Book III.]

THIS genus of animalcules includes the smallest forms in which a voluntary motion has been observed, even under the most powerful Microscopes : this motion, until recently, appeared to be the only property of life with which they were endowed ; but the observations of Dr. Ehrenberg demonstrate an organization equally perfect with animated beings of much larger dimensions. Their forms in general are simple, spherical, or cylindrical masses, devoid of external members or processes* : the mouth, which is with difficulty discerned, is a simple orifice, not furnished with ciliæ or hairs, (except in

* My observations on the *Monas punctum* require a modification of this part of the definition, or removed out of this genus.

one or two species) : they are colourless and transparent as the clearest crystal, yet can no internal organization be seen, excepting that connected with their digestive function, which consists of two or more globular cavities or sacs, probably communicating with each other by a tubular membrane, as in the larger polygastric animalcules, but which in this genus is too minute to be discerned ; indeed, the stomachs or sacs themselves are only to be observed when the animalcule is fed with particles of colouring matter : the food on which they usually exist being as pellucid as themselves, the cavities are invisible. They increase by a spontaneous division of the parent into two or more parts, and those parts, or young, again divide when they have attained their full size.

As subjects of observation they are principally interesting from their minuteness, being as they are the very limit of man's acquaintance with animated nature. Their diameters vary from 1-24000th of an inch to 1-1200th, and consequently require a very high magnifying power to discern. They are numerous, and generally found congregating at the surface, and around the decomposed matter of infusions, either of vegetable or animal substances. Muller enumerates ten species, but Ehrenberg has included fifteen.

1. *MONAS termo.* *The End Monad.*—This animalcule, as its name imports, is *a mere point*, even when viewed under considerable magnifying powers ; indeed it is so very minute, that its existence cannot be discovered in

the best instruments with a less amplification than 160,000 times (or 400 linear), and when higher powers are used (viz. 800 to 1200 times), it requires considerable address in the management of the light in order to exhibit it. The best illumination is obtained by condensed lamp-light, with proper stops to limit the quantity, for they are so delicate and transparent, that if much light be admitted they cannot be seen. In the aplanatic engiscope*, with a power of 800 linear, Dr. Ehrenberg, by feeding them on very finely-divided colouring matter, has been able to discern from two to six spots in them, which, by analogy with the larger infusoria, are stomachs, or digestive cavities. It may also be presumed that they possess, like the larger animalcules, but one orifice or mouth for the reception of food, and that they do not imbibe nourishment by cuticular absorption, as hitherto supposed; and it may be observed that the coloured points occupy the hinder part.

In the drawing, Fig. 1, is represented a group of these animalcules, magnified 800 diameters, or 640,000 times, in surface: in some of them are shewn the dots, as seen when they are fed on indigo: in their natural condition they are merely colourless globules. They differ in size from 1-24,000th to 1-9600th of an inch in diameter; the largest hitherto observed was found at Koliwan; in general they do not exceed 1-18,000th in diameter. They are often so abundant on the surface of in-

* This instrument is commonly known by the name of achromatic microscope. See "Microscopic Cabinet," page 102.

fusions that many millions in a single drop may be taken up on the head of a feeding pin*. In swimming they do not move with rapidity, but as they are seldom entirely at rest, it is difficult to observe them with precision; they are most distinctly seen when the drop has nearly evaporated. The instrument I have viewed them under was an aplanatic engiscope, with deep objectives of 1-6th to 1-12th of an inch focus; if this cannot be procured, doublet magnifiers, or single lenses of 1-60th to 1-100th of an inch focus, are preferable to the common compound. In the solar achromatic, in the confines of the light, young animalcules have been discerned much smaller than 1-24,000th of an inch, and it is probable that more perfect instruments would exhibit even smaller animated beings; to observe these, however, it is necessary to have finely-divided opaque-coloured matter in the fluid.

It may be doubted whether any reasoning being, who has seen these minute living atoms, can contemplate them without the most positive conviction that they are the work of an all-wise Creator, and doubtless intended by Him for some useful purpose in the economy of nature; for if we consider the almost countless numbers that exist in the small space of only an inch, whither will our imagination lead us when we think on the myriads that would occupy the bulk of a single Elephant!

If we take some of the largest of these animalcules,

* See "Microscopic Cabinet," page 235.

and suppose them to be arranged in a line of only one inch in length, it will require 9600 to form it; so that a cubic inch would contain 884,736 millions;—an ocular demonstration, it would seem, of the divisibility of animal matter. And if we investigate the thickness of their skins, or of the tissue which incloses the coloured particles, it will be found to be less than any substance we are acquainted with in inorganic matter; and will afford at the same time a better idea of the minuteness of the particles of vegetable colouring matter than any other method we can devise. Thus, for instance, presuming there are only four particles of colouring matter in each cavity or stomach, and four sacs or cavities in each animalcule, the said cubic inch of animalcules will contain the immense number of 14,155,776 millions of particles; and if the solid matter of the animalcules be supposed to occupy only one half of the space, a solid inch of indigo would contain twice that number of particles.

It may here be noticed that the “active molecules,” described by Mr. R. Brown, are, according to that acute botanist’s measurement, from 1-20,000th to 1-30,000th of an inch in diameter; and although I have examined them under a magnifying power of 3000 times linear, nothing like a vital principle, such as is exhibited by the monads, could be recognized.

2. *MONAS atomus et lens. The Atom Monad.*—This animalcule is defined by Muller to be a white monad with a variable point; while the *Monas lens* he defines to be a transparent monad of a shining talc-like appear-

ance. Ehrenberg, on the contrary, having always found them both in the same infusion, and when fed with colouring matter to be alike, considers them identical: Muller probably inferred a difference, from observing some that had taken opaque food, and others without.

This creature is much larger than the *M. termo*, being from 1-6000th to 1-3450th of an inch in diameter, though more commonly of the latter size. A group of them is represented at Fig. 2, magnified 380 times in diameter. It is the smallest animated being in which the mode of propagation has been distinctly recognized: this is effected, when the animalcule has attained to maturity, by a transverse division into two distinct beings: when this is about to happen, the form of the creature first changes from globular to egg-shaped, gradually elongating in one direction; then a contraction is observed across the middle of the body, as shewn in some of the figures of the drawing, and, finally, the animalcule separates into two. During these changes in its form, it has been mistaken for another species, which shews the caution which should be used in microscopic observations. The age at which they multiply probably depending on their food and the state of the weather, has not yet been determined. The digestive cavities, when filled with colouring matter, are readily seen, and, indeed, are often shewn by their natural food. They have sometimes been seen to swim in company, and even to appear as if connected; in which particular they resemble the young of the *Kolpoda cucullus*, only occasionally sepa-

rating,—a circumstance which distinguishes them from the grape monad.

They are found in most waters containing vegetable matter, and even in sea-water that has been kept some time; but are not so numerous in the latter. A magnifying power of from 350 to 500 is sufficient.

3. *MONAS punctum* (BONO *punctum*, E.) *The pointed Monad*.—These animalcules are slightly noticed by Ehrenberg. They appear as mere dark points, unless seen under a good deep power and proper illumination, when they assume the form of short inflexible cylinders: they are generally found in clusters, and if the microscope be very perfect, a delicate slender filament, or tail, may be seen attached to the middle of each, similar to the filaments or stalks of the common bell polype, but more minute: by the occasional contraction of these filaments the animalcules move by sudden starts, and when several contract simultaneously they appear like scintillations, and have a pretty effect under the microscope, not unlike some kind of fire-works.

The engraving, Fig. 3, represents a group of them, highly magnified; the filaments are not shewn.

They are found in various vegetable infusions; are very abundant about the infused stalks of the spider-wort, *Tradescantia virginia*; and are best seen by lamp-light, under a power of 500 to 600 times.

Ehrenberg has added three other species to the genus Bono, (for their generic characters, see Book III.):

he has not, however, demonstrated the form of their alimentary structure.

4. *BODO didymus*.—Size, 1-9600th to 1-1440th of an inch.

5. — *vorticellaris*. *The whirling Bodo*.—1-1200th of an inch in diameter.

6. — *viridis*. *The green Bodo*.—1-6000th of an inch.

7. *MONAS guttula*, *E. new species*. *The drop Monad*.—This animalcule is larger than the atom monad, and somewhat globular. On account of its size and transparency, its digestive cavities can be much more distinctly observed. It revolves about its longer axis, and in swimming, that part which contains the coloured particles follows the colourless part. Occasionally, with attentive observation, currents in the water may be seen about the fore-part or mouth; it is therefore highly probable that it is furnished with ciliæ or hairs. Those found at Petersburg measured from 1-3000th to 1-2300th of an inch in diameter: they are represented in the engraving, Group 4, magnified 380 times.

8. *MONAS mica*. *The grain Monad*.—The digestive organs of this animalcule have not as yet been observed. According to Muller, it is a monad surrounded by a circle. It does not require so deep a power as any of the preceding, and is capable of elongating itself from a globular to an oval figure at pleasure. It is transparent, and, according to Baker, has a small ellipse inscribed, as it were, within its circumference. This ellipse is move-

able, being sometimes in the middle, sometimes a little towards the fore part, at others nearer the posterior.

The appearance of two kidney-shaped bodies may sometimes be perceived in its centre, and the body is beautifully encompassed with a halo, arising, probably, from fine ciliæ or hairs.

It moves in a variety of ways, and often revolves without changing its situation. Group 5 represents this animalcule magnified : its real size is about 1-1440th of an inch. It is readily seen with a power of 300.

They are found during the summer in clear soft water.

9. *MONAS tranquilla.* *The stationary Monad.*—Egg-shaped, transparent, with a black margin.

10. *MONAS lamellula.* *The laminated, or plate-shaped Monad,* is of a white colour, twice as long as its breadth, very transparent, with a dark margin ; it often appears as if it were double. Its motions resemble vibrations. They are mostly found in salt water.

11. *MONAS pulvisculus.* *The dust Monad.*—Transparent animalcules, with a green margin. When magnified, they appear like small pellucid grains of a spherical form. Their circumference is green. They sometimes swim in company, but are not connected like the grape monad : this it is necessary to remark, as they are about the same size, and might therefore be mistaken for them. Ehrenberg has not observed them in clusters, but has distinctly discerned their mouths, which are furnished with from ten to twenty ciliæ, or hairs. A line of a dark green colour may be observed in some specimens across

the middle, when the animalcule is about to divide into two. They swim with a wavering motion, and are mostly found during the spring in small pools in marshes.

12. *MONAS uva*. *The grape Monad*.—These animalcules are principally distinguished from the former by their being connected together, like a bunch of grapes. The diameter of a single one is 1-10,000th of an inch. Ehrenberg has not demonstrated the existence of the digestive sacs in this species.

These animalcules have some resemblance to the *Gonium pectorale*, but the clusters are smaller, and more irregularly shaped; the number in a cluster varies from four to seven or eight. They are the more sluggish the larger the cluster, only rolling about from place to place; but when separate they swim with great celerity.

If one of these be placed under favourable circumstances, and watched for some time, it will be found to increase greatly, during which a number of lines are observed on its surface: these gradually strengthen, until at last the individual bursts into a cluster. Found in vegetable infusions. The engraving, Fig. 6, will afford a general idea of this and the preceding species.

13. *MONAS crepusculum*, E.—This species is the same size as the *M. termo*: it is found in infusions of fungus, especially the mushroom; and as it will not feed on *vegetable* colouring matter, its organization has not been demonstrated.

14. *MONAS enchelis*, E. *The flask-shaped Monad*.—A new species; 1-1200th of an inch in size.

15. *MONAS erubescens*, E. *The glowing Monad*.—A new species, measuring 1-1728th of an inch.

16. *MONAS hyalina*, E. *The diaphanous Monad*.—A new species, measuring from 1-6000th to 1-2880th of an inch.

17. *MONAS kolpoda*, E. *The bosom Monad*.—A new species, measuring only 1-10,320th of an inch.

18. *MONAS ovalis*, E. *The egg-shaped Monad*.—A new species; size, 1-9600th of an inch.

19. *MONAS polytoma*, E. *The indented Monad*.—A new species, the largest of this genus; 1-1100th of an inch.

20. *MONAS umbra*, E. *The clouded Monad*.—A new species, size 1-2400th of an inch.

21. *MONAS volvox*, E. *The revolving Monad*.—A new species, found at Petersburg, from 1-3456th to 1-1728th of an inch in diameter.

GENUS II.

P R O T E U S.

WE now arrive at a larger genus of animalcules, whose habits are highly interesting and curious : indeed, there are few in the examination of which I have been more delighted. This gratification arises, not so much from any complexity in their organization, which, in comparison with the *Branchionus*, and some of the *Vorticella*, is more simple, but from the great power they possess of dilating their bodies ; and their motions being slow, the observer is enabled to examine their changes of form distinctly.

Their generic character, according to Muller, is, “ that their form is changeable, extending variable feet-like processes at pleasure.” This naturalist has only enumerated two species, to which Schrank has added two others ; and Sosano, in the Transactions of the Turin Academy, Vol. xxix., has extended this genus to sixty-nine species.

22. *PROTEUS diffluens*, (*Amoeba diffluens*, E.) *The melting Proteus*.—This changeable animalcule may be said to have no determined form, for it is continually varying its shape under the eye of the observer. It is a very soft

body, of a grey colour, sufficiently transparent to exhibit its internal contents. When in its greatest contracted state, it appears like a gelatine ball; this it readily changes, thrusting out branches of different dimensions in various directions. Some of its numerous forms are shewn in the group, figures 8, 9, 10, 11, and 12. When it swallows animalcules which are covered with a crustaceous shell, as in figures 9, 10, &c. it accommodates its shape to the food. The mouth aperture is situated at the cross in figure 9. Their digestive organs consist of a number of sacs, possessed of considerable dilating power; and when they are fed on indigo, carmine, or other minutely divided bodies, they remain circular: several of these are shewn in figure 12, and one at the lower part of figure 9. That their stomachs are capable of great expansion, is evident from the large bodies they have swallowed.

The drawing, figure 9, I took from a specimen found in some water containing duck-weed (*lemna major*), in the month of March. They are very scarce. Muller states he only saw them twice.

Their diameters vary from 1-600th to 1-300th of an inch. Figures 10, 11, and 12, represent the same creature magnified 380 times; and the long animalcules within them are species of the Bacillaria, which it has seized and eaten: they serve to exhibit the wonderful dilatation of their stomachs.

23. *PROTEUS tenax.* *The tenaceous Proteus.*—This animalcule, like the former, is gelatinous, and changes

its form, but always in a regular order ; first extending the lower end, which is terminated by a fine point, then swelling out the fore part into a globular mass ; and thus, by alternate contractions and dilatations, it draws itself forward in the water, which it does very slowly. It is found in river-water, and shewn magnified at figure 7.

The above are the only species given by Muller. Ehrenberg has observed another, which he has named—

24. *AMOEBÆ radiosa* ; it having variable acute radiated processes.

GENUS III.

VOLVOX.

THE animalcules belonging to this genus are of a globular form, and revolve in the water. Some of the species are so large as to be discerned by unassisted vision, while others are very diminutive. Ehrenberg has not demonstrated their digestive organization; but in a note to his table, conceives they ought to follow the monads. In this genus is included that beautiful animalcule, called the *Volvox globator*, which forms so interesting a spectacle in the Solar and Gas Microscopes.

25. *VOLVOX punctum*. *The point Volvox*.—This volvox takes its name from the appearance of a bright point in the centre. It is spherical, with one part opaque and black; the other portion transparent and colourless. A violent internal motion is often observed in the dark part. It swims in a tremulous manner, and often passes across the drop of water, and occasionally turns upon its axis. They congregate together, moving as in a little whirlpool, and then separate. Found very abundant on the surface of foetid sea-water.

26. *VOLVOX calamus*, (new species, Mihi). *The pipe Volvox*.—This pretty little animalcule, about the 1-1500th

of an inch in diameter, is generally of a bright red colour, of a globular form, with a small diaphanous tube protruding from one side, and slightly enlarged at its extremity, like a trumpet : its length is equal to the diameter of the animalcule. This pipe, I am inclined to believe, is its sucker, or proboscis, by which it imbibes nourishment. In swimming, it oscillates in front of the animalcule. They are found, during the spring and autumn, along with the green *Cercaria*, and are the prey of the genus *Bursaria*.

27. *VOLVOX granulum*. *The grain Volvox*.—Muller defines this animalcule to be spherical, of a green colour, with a bright circumference.

The centre is of an opaque green, surrounded by a transparent annulus. It is found in marshes during June, and has a slow motion. See figure 13.

28. *VOLVOX globulus*, (*Doxococcus globulus*, E.)—*The ball Volvox*. This animalcule is nearly ten times the size of the atom monad, or about 1-860th of an inch in diameter : it is placed by Ehrenberg immediately after the monads, though he has not demonstrated the polygastric form of its stomach ; it is globular, but sometimes slightly egg-shaped : the hinder part is generally opaque, probably from the food it contains : its motion is slow and fluttering, but when disturbed is more rapid.

29. *VOLVOX pilula*. *The pill Volvox*.—A small round transparent animalcule, with green spots. The circumference is usually of a yellow green colour. A magnified view of it is shewn at figure 14 : the upper part, marked

by a cross, is probably the mouth. It sometimes appears encompassed by a light circle, occasioned by fringes of hair: in a specimen which measured 1-1200th of an inch in diameter, I could distinctly perceive the ciliae when the creature was at rest. The magnifying power used was about 400. Its motion is various; sometimes slow, at other times rapid: it is found amongst the small duck-weed (*Lemna minor*), near the surface of the water.

30. *VOLVOX grandinella*. *The hoar-frost Volvox*.—This animalcule is much smaller than the preceding, and is marked with several circular lines: no internal motion is observable among the opaque molecules. It is irregular in its movements; sometimes swimming in a straight line, at others zig-zag, and often remains in the same spot, producing a tremulous motion. Muller defines them as “spherical and opaque, with immoveable intestines.” It appears to me to be the same species as the pill volvox, in another stage of its growth.

31. *VOLVOX socialis*. *The clustered Volvox*.—“Spherical volvox, with crystalline molecules, placed at equal distances from each other.” When much magnified, this animalcule resembles the *Vorticella socialis*. It consists of several transparent molecules, commonly of a pale brownish-green colour, disposed in a globular cluster: they are of a uniform size, and their outer ends are somewhat conical or egg-shaped. Whether they are inclosed in a common membrane, or united by a stalk, has not been demonstrated, though I am inclined to be-

lieve they are only attached by the posterior end of the membrane of each globule, having observed them in pairs separate from the cluster. Their motion is sometimes rotatory, at others to and fro. Muller found them among the *Chara vulgaris*. I found them plentifully in the ponds at Hampstead. They congregate about the side of the vessel in which they are kept. The diameter of the clusters varies from 1-400th to 1-1000th of an inch: a power of 200 is necessary to observe them distinctly, but they may be discerned with a lens of a quarter-inch focus, that is, a power of 40. Figure 15, in the engraving, represents a magnified cluster of these curious animalcules.

32. *VOLVOX sphærulea*. *The spherical Volvox*, with round internal molecules.—This animalcule is formed of pellucid homogeneous specks of different sizes. It moves slowly about a quarter of a circle in one direction, and then returns.

33. *VOLVOX lunula*. *The moon-shaped Volvox*.—An hemispherical animalcule, composed of lunular molecules. It is transparent, and the cluster is of the form shewn at figure 18. The mass is in continual motion, turning about in the water, while, at the same time, the individuals of which it is composed appear to change their situation. They are found in marshes at the beginning of spring.

I am unacquainted with this animalcule, and am inclined to suppose it is merely a cluster of animalcules coiled together indiscriminately.

34. *VOLVOX uva.* *The grape Volvox.*—This animalcule appears in a cluster, arranged in various forms, resembling bunches of grapes, from which its name is derived. They are sometimes of a transparent green colour, at others perfectly colourless, like clusters of balls of glass, roving about near the surface of the water; indeed, so pellucid are they, that when in company with any darker animalcules they may be easily overlooked. These creatures afford a curious example of the diversity of form in the animated world: so different are they from any living thing on a larger scale, that the mind involuntarily questions the vitality of these moving clusters; the more especially as no external members have as yet been discovered: no scrutinizing observer, however, who will devote a few minutes in following their motions, will, I am convinced, doubt of their animated existence, while he will derive considerable pleasure in watching them through a series of the most diverting gambols, surpassing by far any of the most playful domestic animals.

The groups vary in form as much as different clusters of grapes, and consist of from four to sixty globules each, while occasionally a single one may be observed separated: these, when of a green colour, resemble the *Gonium pectorale*; indeed, in clusters, they do not differ much from the latter, except in their symmetrical arrangement.

The magnifying power necessary for shewing these animalcules should be from 100 to 250 times (linear).

With an achromatic microscope of a power of 500, they form a most beautiful object, and various indentations and markings may be detected on the surface of each globule, which are worthy of investigation, as we know so little about their structure. The diameter of the clusters varies from 1-600th to 1-1500th of an inch: when arranged in a globular mass they resemble the *Volvox socialis* (see figure 15), of which I imagine they are only a variety.

I have found them very abundant during the month of September, on the surface of ponds, covered with a brownish green film. When a drop of the water is placed upon the stage-glass of the microscope, the upper surface of it should be carefully examined before it is covered with mica or glass, as I have found them invariably to float on the water.

35. *VOLVOX morum*. *The mulberry Volvox*.—This group of animalcules differs from the former species in the shape of the cluster, which is of a globular form, like the fruit of the mulberry-tree, and the whole inclosed in a transparent membranous envelope. The individual globules, in which may sometimes be observed a slight motion, are usually of a bright sea-green colour, while the envelope which surrounds them is clear and pellucid, like glass. The cluster swims slowly, rotating as it progresses. They are found, during the latter months of the year, at the surface of ponds, covered with vegetation. Figures 16 and 17 represent two clusters of the mulberry Volvox, highly magnified: in the larger animalcule the internal cluster has separated into several

smaller ones, around each of which a separate envelope is about to be formed, ; it will then divide into six distinct clusters.

36. *VOLVOX vegetans. The vegetable Volvox.*—This animalcule is rather scarce. Its most interesting characteristic is the short time which it requires in arriving at maturity, and undergoing all its changes. In the space of half an hour, when fed with an infusion of indigo, a single globule may be observed to emerge from a naked branch, increase in size, and divide into a cluster of smaller ones ; these increase also, and after revolving, and bringing a current of food towards them, finally separate, and swim away, each of the young ones commencing a similar course.

It consists of several opaque branches : at the termination of each is a small congeries of egg-shaped transparent bodies, as represented, magnified, at figures 19, 20, and 21. Muller, who seems to have only seen them once, mistook them for a vegetable production, until he observed the clusters to separate from the branch, and swim about at pleasure.

These animalcules produce a rapid current of water towards them, as indicated by the arrow in figure 19 ; and if supplied with plenty of coloured food, as indigo, they will not only assume the colour of the particles, but may be seen to increase in size, under the eye of the observer. When the cluster is fully developed, it breaks off, and swims away, revolving as it proceeds. (See figure 20). After roving about for a few minutes in search of a

proper nidus to attach itself to, it spins a very delicate thread, like a spider's web, one end of which it fixes to the substance it has selected : this filament, when drawn out to the proper length, increases in size, and assumes the deep blue colour of the indigo, while the end of the stalk which it left shoots forth a fresh cluster.

The current above mentioned is sometimes produced without any revolution of the cluster of globules ; at other times I have observed the whole cluster to revolve.

The magnifying power which I employed, while making the drawing, figure 19, was nearly 500 times : under a power of 200 they resemble figure 21, and a greater number of branches may be seen at once. The medium diameter of the clusters, while attached to their branches, I find to be about the 800th part of an inch ; and when fully developed and separate about 1-400th of an inch.

Muller discovered them in river-water, in the month of November. Those on which the above observations were made, I found in the month of June, in some pond-water.

37. *VOLVOX globator. The globe Volvox.*—This popular and diverting animalcule was discovered by Leeuwenhoeck, and has been described by all subsequent writers on microscopic objects. As its name imports, it is of a globular form ; its colour is usually a light green, though I have met with some of an orange brown, which, however, are generally smaller than the green ones. The envelope is composed of a diaphanous

membrane, beneath the surface of which is disposed, at equal distances, small spherical bodies of a green colour. These granular bodies have been supposed to reside on the exterior, and by some have been mistaken for hairs; but that they are actually within the envelope is evident when the circumference of the globe is accurately brought into focus. The proximity of these pustules is greater the younger the specimen, and as these pustules contain the colouring matter of the animalcule, the young always appear more coloured than the old ones, as the transparent spaces between the pustules is augmented in the latter, and spread over a greater surface. Within the parent is often seen a number of (from six to forty) smaller ones, and even within these, when about to be excluded, another generation may be observed. The young within the parent, which, by the way, forms the most striking characteristic of the species, may be observed at first attached to the inside of the membranous covering, but long before their birth revolving freely in the parent, and others again within them. In parturition, a portion of the parent globe is broken, and the young are gradually and slowly evolved; when this is completed, like the fabular Phoenix, the parent dies, and its body separates into numberless parts.

This singular animalcule, to use the words of Baker, “ moves in all directions; forwards, backwards, up and down, rolling over and over like a bowl, spinning horizontally like a top, or gliding along smoothly without

turning itself : sometimes its motions are slow, at others rapid.”

The diameter of this animalcule, when full grown, is about 1-30th of an inch, and is therefore easily perceived by unassisted vision : a magnifying power of 100 times is sufficient.

It is found most abundant, during spring and summer, in ponds and stagnant water ; and often in the same water with young lizards and frogs. Infusions of hemp-seed and tremella are said to abound with them.

Figure 22 represents a globe animalcule, magnified, with four smaller globes within it.

GENUS IV.

ENCHELIS.

THIS genus of animalcules, according to Muller, contains twenty-seven species. His definition is, “a simple, invisible animalcule, of a cylindrical form.” In the papers of Ehrenberg, the *Enchelis deses* is placed in a new genus, under the name BACTERIUM, (see Book III.) and he has added ten new species; these I place after the *E. deses*. It is highly probable that patient observation, with good instruments, will demonstrate that several of the animalcules which are given as distinct species of this genus are merely different stages in the growth of others.

The size of the different species varies considerably, and therefore require different magnifying powers to exhibit them (from 200 to 500 linear). If the reader have an opportunity of examining any of them, in instruments of different constructions, but of the *same* magnifying power, he will readily perceive that there is something besides magnifying power that is essentially requisite in a microscope, in order to shew the details of objects.

38. *ENCHELIS viridis*. *The green Enchelis*.—This animalcule is usually of a dark green colour, “sub-cylindrical figure,” with its anterior part obliquely truncated, as shewn at the cross in the magnified drawing of

it at figure 23. It is very restless, continually changing its position. Found in water that has been kept for some time and become fœtid.

39. *ENCHELIS punctifera*. *The dotted Enchelis*.—This species is of an opaque green, like the last, but has its posterior terminated acutely, and the anterior or head rounded obtusely. A small pellucid spot may be observed in the latter, and sometimes two black points. When it is about to propagate, which it does by a transverse division of the body, the centre becomes more transparent, giving the appearance of a band around the middle of the body. The mouth, as usual, is marked by a cross. A drawing of it, magnified, is given at figure 24. I conceive it probable that further observations may find it to be only a variety of the *Cercaria viridis*. Found in marshes.

40. *ENCHELIS ovulum*. *The egg-shaped Enchelis*.—This animalcule is distinguished by its pellucid appearance and the longitudinal folds of the external membrane. A few bright spots are also sometimes observed; these have been supposed to be the ova, but it is more probable they are the sacs of the polygastric structure. Figure 24' is a magnified representation, shewing the sacs and folds, neither of which are constant. Found in stagnant water.

41. *ENCHELIS fritillis*. *The dice-box Enchelis*.—In accordance with Muller's arrangement, I have given this animalcule, though there is no doubt it is a species of the *Vorticella* before the foot-stalk has grown, (see *Vor-*

ticella convolaria): this is rendered more probable by his suspecting the existence of rotatory ciliæ at its anterior end. Its form is a short cylinder, truncated and hemispherical at the posterior, as shewn, magnified, at figures 25 and 26. It is a very transparent animalcule, and moves about in the direction of its axis with an undulating motion; sometimes revolving. Found in infusions of hay and grass.

42. *ENCHELIS seminulum*. *The seed-shaped Enchelis*.—The specific characters of these animalcules are, “cylindrical, with both extremities alike:” their length is about twice their diameter; the anterior and posterior parts are nearly of the same sphericity; the fore part generally more transparent. In swimming, it usually ascends and descends in the water; sometimes two are observed united by their anterior ends, probably not completely divided. Found in stagnant water. Size, 1-1200th of an inch.

43. *ENCHELIS intermedia*.—This animalcule is described as intermediate between the last species; the *Monas punctum*, and the *Cyclidium milium*. It is very minute and transparent, the edges rather dark: nothing has been observed in its interior. The extremities are similar; sometimes a mark is observed across the middle, which induced the supposition that it had arrived at maturity, and was about to divide. Found in an infusion of *Leucajon flaviatilis* (?) by Muller.

44. *ENCHELIS pirum*. *The pear-shaped Enchelis*.—The head of this animalcule is at the larger extremity, which

is also more opaque than the posterior one : an internal peristaltic motion may be observed. It is lively and active, swimming with celerity. When quiescent, which is seldom, an external swelling may be seen near the middle of the body.

45. *ENCHELIS tremula*. *The vibrating Enchelis*.—This animalcule is very minute and transparent : it is rather pointed at one end, and has a tremulous motion, which, if examined in a perfect microscope, would probably be found to arise from a filament or tail. Found along with the *Paramæcium aurelia*, and other animalcules.

46. *ENCHELIS constricta*. *The contracted Enchelis*.—This animalcule is very diaphanous and small, of an oblong form, and contracted about the middle. It is probably some other species undergoing division. Found in sea-water.

47. *ENCHELIS pulvisculus*. *The dust Enchelis*.—This is also a very minute and pellucid species. Its form is like an egg, but much longer in proportion to its diameter : the inside appears filled with green powder. They congregate in great numbers, and are found among the green matter on the sides of vessels in which river-water has been kept.

48. *ENCHELIS fusus*. *The spindle-shaped Enchelis*.—The drawing of this animalcule, magnified in figure 27, will convey a better idea than description. I think it is included by Ehrenberg among the *Bacillaria*. A bright wavy line may be sometimes discerned, apparently internal. It moves but seldom, and then slowly : I have

met with it among healthy duck-weed, and it is said to be found in pure water.

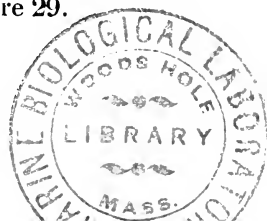
49. *ENCHELIS similis*. *The ring Enchelis*.—This species is opaque, with a pellucid margin. It is of a globular form, inclined to an oval, and filled with moveable spherules. The pellucid appearance of the edges is probably occasioned by a fringe of ciliæ. It moves very rapidly. Found in river-water, kept for some months.

50. *ENCHELIS serotina*. *The sluggish Enchelis*.—This is an egg-shaped animalcule, with its fore part rather pointed. The margin is dark, and the interior filled with immoveable grey molecules: it moves slowly. Found in marshes, in September.

51. *ENCHELIS nebulosa*. *The nebulous Enchelis*.—This is a very scarce animalcule; found along with the *Cyclidium glaucoma*. It is of an egg shape, with the fore part not so pointed as the last species, and the interior is in motion. In swimming it keeps the head inclined upwards, and is about 1-400th or 1-500th of an inch in length. (See Book III).

52. *ENCHELIS caudata*. *The tail Enchelis*.—This scarce animalcule is of a grey colour, with small molecules within. Its form is shewn, greatly magnified, at figure 28. The head is terminated obtusely.

53. *ENCHELIS epistomium*.—This species is very minute and diaphanous: the body is cylindrical, and terminated obtusely; the head is globular; a dark line is sometimes observed down the middle. See figure 29.



54. *ENCHELIS gemmata*. *The brilliant Enchelis*.—This animalcule is about the size of the last species. The body is more cylindrical, and has two rows of bright globules running down the interior; the neck is elongated, and very transparent: the whole resembles a Champagne bottle. Its motion is slow. Found in stagnant water among duck-weed.

55. *ENCHELIS retrograda*.—This gelatinous animalcule usually moves sideways, like a crab, and sometimes backwards. The body is thickest in the middle, and tapers off at each extremity: when obstructed in its motion, it draws itself up like figure 30. The anterior end is marked by a cross.

56. *ENCHELIS festinans*. *The restless Enchelis*.—This animalcule is found in sea-water; it is very diaphanous, and of the form shewn in a magnified view, figure 31. The anterior part is marked with a cross. It is in constant motion, and appears as if vibrating from one side to the other.

57. *ENCHELIS index*.—This curious species of *Enchelis* is capable of varying its form. Sometimes it assumes a globular shape; at others, a small projection may be seen, as at figure 32, while its most common form is shewn at figure 33, its anterior part having two projections like a finger and thumb. It is of a grey colour, and moves slowly. Found among the small duck-weed.

58. *ENCHELIS spathula*.—This animalcule is represented, magnified, at figure 34. The body is marked by

longitudinal furrows, and a few transparent globules; the fore part flattened out like a spatula, the corners of which it can withdraw at pleasure. Its motion is wavy.

59. *ENCHELIS truncus*. *The truncated Enchelis*.—This animalcule is the largest of the genus: it is capable of altering its form, which is oblong, each extremity being obtusely rounded: sometimes its anterior end is expanded into a globular mass, when it also occasionally sends out three lateral projections, like teeth. In this condition it is shewn, magnified, at figure 35. In progressing it rolls about slowly, and swims in a direct course.

60. *ENCHELIS larva*.—This animalcule resembles the *Enchelis caudata* (see figure 28), but is distinguished from it by a slight contraction near the head, forming a neck, and also by a small projection on each side of the body. It is found in marshes, and is very scarce.

61. *ENCHELIS pupula*.—This species resembles in form a pear; the anterior part is like the base of that fruit, out of which issues, in place of a stalk, a papillary projection; while at the other end may be observed a large transparent circle. The fore part is dark, and filled with moveable molecules. It swims obliquely in the water, occasionally rotating on its longer axis. It was found in water drained from a dunghill, in November.

62. *ENCHELIS deses* (*Bacterium deses*, E.) *The slothful Enchelis*.—This animalcule is of a dark green colour, with the ends lighter. Its form is given at figure 65.

It is very inactive and slothful. Found among duckweed. Length, 1-1200th of an inch.

Ehrenberg has placed it in a new genus (for the characters of which, see Book III.) He has also given the following species :—

63. *BACTERIUM cyclidric.*—1-1100th of an inch.

64. ————— *enchelis.* *The flask Bacterium*, al. sp.
—1-2880 of an inch.

65. *BACTERIUM fuscum*, al. sp.—1-1500th of an inch.

66. ————— *monas.*—1-4000th of an inch.

67. ————— *punctum.*—1-4000th of an inch.

68. ————— *termo.*—1-6000th of an inch.

69. ————— *tremulans.*—1-3400th of an inch.

70. *ENCHELIS pupa et farcimen.*—*The puppet flask Animalcule*, and the *E. farcimen* are given by Muller as distinct species, but in fact they are the same at different stages of its growth ; the forms it assumes are influenced by the prey it feeds on. Figures 36 and 37, which represent young ones, are the latter, and figure 38 the former species of that naturalist.

This animalcule is furnished with a fringe of ciliæ around the mouth, as shewn in figures 36, 37, and 38 ; by means of this it can occasion currents in the water, as indicated by the arrows in figure 38. Its digestive function is not performed by a simple alimentary canal ; but in the apparatus shewn at figure 41, a large digestive trunk, traversing the body from one extremity to the other, slightly enlarged near the end, and sending out branches in all directions, at the termina-

tion of which are small globular cavities, in which the food is digested. This apparatus, and indications of ovary clusters, probably attached to the main trunk, are all that has been discovered of its internal organization. All the figures are magnified in the same proportion, and the real length of a mature specimen (Figure 38) is 1-140th of an inch.

These creatures prey on other animalcules nearly as large as themselves, which they devour entire; this will account for the variety of forms which they assume, and require an observer to be very watchful and cautious, before he can pronounce on the identity of a species. Dr. Ehrenberg, by patient observation, saw one individual undergo a great variety of forms, when it had swallowed a young *Kolpoda cucullus*. To explain this effect, figure 36 shews a young specimen with open mouth, about to devour the animalcule at figure 39: this it accomplishes by the motion of the fringe of ciliæ producing a current in the water: the prey by this means is brought in contact with the mouth-aperture, which gradually dilates till the animalcule is entirely enclosed. During this operation it swims about, and a casual observer would readily imagine the form shewn at figure 40 as the normal shape of an animalcule, while, in fact, it is occasioned by its food. As the digestion proceeds, the lower part dilates, and the anterior contracts into its former shape; the animalcule then assumes an egg-shape, and finally returns to its true form.

GENUS V.

VIBRIO.

THE extensive range of this genus, in regard to the structure, form, and size of the different species, offers great variety to the observer. The complex organization of the *Anguillula*, the singular form of the *spirillum*, and the diverting manners of the *olar*, will afford the microscopist considerable information and amusement; while the investigation of the division, Bacillaria, on the very verge of the vegetable kingdom, will require his patient attention, and strain the powers of his microscope to the utmost.

Regarding this genus in a scientific point of view, it is the most vague and indefinite in Muller's system, either as regards their external characters, or internal structure: it includes animalcules both membranous and crustaceous; some as slight as a thread, others whose breadth nearly equals their length; some whose organization is so complete that modern naturalists have entirely excluded them from the Phytozoa; and others, which are with difficulty distinguished from vegetables. To diminish somewhat these incongruities, without rendering the arrangement complex, I have separated them into three divisions. The first is the simplest, and requires a magnifying power of from 200 to 500 times to examine

them; the second and third vary so much in size that some do not require half that power, and a few even less, being just discerned by the naked eye. The definition given by Muller to the animalcules under this name, is, *an invisible worm, very simple, round, and rather long.*

FIRST DIVISION.—BACILLARIA.

These minute and inactive animalcules are covered with a hard shell-like coat, and appear closely allied to some of the small fresh-water Algæ, and are not very appropriately classed with the *Vibrio*; but as their internal structure has not been demonstrated, and Muller has included some in this genus, I here introduce the group.

(A.) *Animalcules covered with a quadrangular bivalve shell, divided across the back.*

(a.) Distinct individuals, single or gregarious.

Smooth:

71, NAVICULA (shuttle-shaped) *fulva*. *The yellow Navicula*.—(See p. 37).—Size, 1-400th to 1-720th of an inch.

72. ——— *gracilis*. *The slender Navicula*.—Size, 1-400th to 1-1500th; new species.

73. ——— *ulna*. *The arm Navicula*.—Size, 1-120th.

Striated:

74. ——— *fusiformis*. *The spindle-shaped Navicula*.—1-360th to 1-430th; new species.

75. *NAVICULA gibba*. *The crooked Navicula*.—1-120th to 1-144th ; new species.

76. ——— *turgida*. — 1-120th to 1-600th ; new species.

77. ——— *uncinata*.—1-240th ; new species.

(b.) Distinct individuals connected together in various forms.

Stick or rod-shaped.

78. *BACILLARIA elongata*.—1-480th ; new species.

(c.) Distinct individuals connected in bundles not varying in form, occasionally broken.

79. *FRAGILARIA angusta*.—New species ; 1-480th to 1-576th.

80. ——— *bipunctata*.—New species ; 1-1200th.

81. ——— *pectinalis*.—1-576th.

82. ——— *scalaris*.—New species ; 1-576th to 1-900th.

(d.) Distinct individuals, without foot-stalks, radially disposed (like a fan).

83. *EXILARIA flabellum* —New species ; 1-960th.

84. ——— *panduriformis*.—New species ; 1-430th.

(e.) Fixed sessil.

SYNEDRA.—New genus.

(f.) Animalcules fixed by a pedicle or stalk ; sometimes in pairs ; fore part dilated.

85. *GOMPHONEMA discolor*.—New species ; 1-600th.

86. *GOMPHONEMA rotundatum*.—New species; 1-240th to 1-288th.

87. —————? *clavatum*.—New species; 1-768th.

88. —————? *constrictum*.—New species; 1-900th.

(g.) Animalcules fixed by a pedicle or stalk; sometimes in pairs; both ends contracted.

89. *COCCONEMA cistula*.—(New genus); 1-600th to 1-1500th.

(h.) Animalcules fixed by a stalk, radiated (like a fan).

ECHINELLA.

(B.) *Animalcules inclosed in univalve shells, round, divided transversely into two or four parts.*

90. *CLOSTERIUM cornu*.—New species; 1-2400th of an inch.

91. ————— *lunula*.—1-96th to 1-120th.

92. ————— *trabecula*.—New species; 1-96th.

93. *VIBRIO bipunctatus*. *The two-dotted Vibrio*.—This is a very inactive animalcule, of a brown colour and cylindrical form, truncated at each end, with two dots near the middle. In some specimens only one dot is observed. Their real length is about 1-200th of an inch. It is probably the *Fragilaria* of Dr. E.

94. *VIBRIO tripunctatus*. *The three-dotted Vibrio*. (*NAVICULA*, E.)—This animalcule is distinguished from the last species by its conical ends, and by three globular points, or a few transverse markings (see group 42).

The space between the diaphanous globules is generally filled with minute green particles : it moves but seldom, and appears at first indifferent which end shall proceed foremost. They are eaten by the *Proteus diffluens* and the large *Vorticella*, which see.

The oat animal described by Baker is probably only a variety of the two preceding species, and as he seems to have examined them more accurately than Muller, I shall append his account of them for the information of the reader.

“ This creature is so very small that no true judgment can be made of it unless it be looked at through the greatest magnifier, nor even then without considerable attention. I commonly found two or three of them in a drop of the sediment, amongst multitudes of the hair-like insect, lying at the bottom of the water wherewith the sediment was diluted upon the stage-glass, without any visible motion or appearance of life. They are inclosed in a bivalve shell, which the animal can open or shut at pleasure, but which it constantly shuts upon being disturbed, nor opens again until after having been quiet for some time.

“ The shell is so exquisitely thin, and consequently so very transparent, as to be traced out, when shut, only by a faint line on the back, where the cardo or hinge makes some additional thickness ; but when open, the edges of both its sides may be plainly distinguished. The two ends of the shell can open whilst the middle part remains closed, and in that condition it is like the *Pholas*, and

some species of the *Chama*, and only differs from them in being able to shut both ends, and alter the figure of its shell, which they cannot do : this, probably, is performed by means of certain articulations in the shell near its extremities, which are too delicate to be discerned. When these ends are open, the creature frequently thrusts out at each a cylindrical fleshy part, which may be supposed the head and tail, but their minuteness renders it hardly possible to discover any difference between them. In this posture, it is probable the creature feeds on the provision that surrounds it, though it depends not wholly on such accidents, for it can change its place by jerks or leaps, which it effects by the action of some strong muscles in the two protruded parts, whose spring throws it to the distance at least of its own shell's length every time they are exerted. These leaps, however, have long intervals between, and are never made until the animal is perfectly undisturbed."

The body, as well as the shell, is usually so transparent that when the latter is closed nothing can be perceived but a slight shade within it; but occasionally I have seen the body distinctly through the shell.

" Some specimens have two or more transverse lines across the body, dividing the animalcule into zones : others have a couple of dark round spots ; the latter I imagined to be compact ligaments, serving to open and shut the shell, and similar to those that oysters, muscles, &c. are furnished with for the like purpose : but when

I observed others having three, four, or five round spots, I began to think myself mistaken; and should rather suppose them concrete bodies, similar to the pearls in several kinds of shell-fish, did not the regularity of their position render this likewise improbable.”

95. *VIBRIO paxillifer*. *The stick Vibrio*. Group 43.—This animalcule, or rather congeries of animalcules, for they are mostly attached together in different forms, when magnified appear like pieces of straw of a pale yellow colour, with the inside of an orange brown. They are nearly round, and, if attentively watched, may be seen occasionally to turn upon their longer axis, when a longitudinal line may be observed; this is, probably, the hinge or opening of their shell. They vary in length from 1-100th to 1-500th of an inch, and their diameter is from 1-20th to 1-100th of their length: they require considerable magnifying power, and large angular aperture, to distinguish their structure. Muller has no doubt included several distinct species under this name. (See BACILLARIA.) I find, on reference to my notes, made at different times, that it was not until after I had examined them repeatedly I became satisfied of their animal vitality. They generally reside at the bottom of ponds, but after rain are met with near the surface, giving the water a green tint; in such cases they are found separate, the agitation of the water having broken the clusters.

The *hair-like* animalcule of Baker is nearly allied to

this species ; and as his description contains some remarks applicable to the group, it is here appended, slightly abridged.

This wonderful animalcule was discerned by Mr. Anderson. It is extremely slender, and often 150 times longer than broad : the body is nearly straight ; the ends are slightly curved in opposite directions, and resemble each other so closely that it is difficult to distinguish them. Some appear covered with rings ; in others, the rings cross each other obliquely, and in some the body seems covered with scales. As it is incapable of bending, it either moves forward in the direction of its length, or if desirous of moving in an oblique direction, it describes the arc of a circle with one end, and then with the other, alternately, making each extremity the centre of rotation. They were discovered in a large ditch running into a river near Norwich, the bottom of which was covered with them to some thickness : when first examined, being motionless, they were taken for vegetable fibres, but on keeping them under the microscope, without disturbing, and occasionally viewing them, they were seen to move, and form themselves into companies, in various forms. After putting a large spoonful of the green water, containing these animalcules, into a glass vase, and gently filling it with clean water, without disturbing those at the bottom, they formed themselves into a column, and in a few days ascended to the surface. (I may here remark, that they usually ascend on that side of the vessel which is most exposed to the

light : whether this preference is the choice of the animalcules, or influenced by an ascending current in the water, I have not ascertained. Baker makes no mention of the fact.) When exposed at the surface of the water for a short time, the colour of the animalcules is changed from a bright green to a sky-blue ; but they are sometimes so numerous as to cover the mud at the bottom of the pond for several inches in thickness ; the masses then appear almost black. When in small companies, they are nearly of the same specific gravity as the water, and therefore when placed at any depth appear stationary. A small quantity of this matter having been put into a jar of water, one part went down to the bottom, whilst the other continued floating upon the top. All things remained for some time in this condition, until at last each swarm of animalcules grew weary of its situation, and had a mind to change its quarters. Both armies, in short, began their march at the same time, against the side of the jar, and as one proceeded upwards and the other downwards, after some hours they were nearly meeting about the midway, as the route each of them appeared to take, soon after they began to move, made it very easy to foresee. The desire of knowing in what manner they would behave on this occasion, engaged the observer to watch them with a careful eye ; and as they approached still nearer, he beheld to his great surprise the army that was marching upwards open to the right and left, and leave a convenient space for the army which was marching downwards to pass between

its wings. Thus, without confusion or intermixture, each held on its way ; the army which was going upwards marching in two columns to the top, and the other proceeding in great regularity and order in one column to the bottom. This amusing spectacle serves to shew that, however mean or contemptible these creatures may appear to us, the Almighty Power that created them has not left them destitute of sagacity to associate together, and act unanimously for the benefit of the community, both these armies marching as regularly as if under the direction of wise leaders.

When these animalcules are taken from the ditch, and other water is poured upon them, it is difficult to make them live twenty-four hours ; but when kept in some of the same ditch-water, they may be preserved in good condition for several months. Though they are never so vigorous, nor shew their way of moving from place to place so plainly as when first caught, their kind of motion, as before described, makes it evident, that if they move along the side of a cylindrical glass jar, either upwards or downwards, it must be in a spiral line, and such it is always found to be.

96. *VIBRIO lunula.* *The Moon-shaped Vibrio.*—Two specimens of this animalcule are drawn, magnified, at group 44, which will give the reader a general idea of its form. In the larger drawing, the interior of the animalcule was of a green colour, with a row of diaphanous globules down its centre, and the sides between the granulated parts and the shell almost colourless.

Like the three preceding species, little is known of their habits: it is probable that the lighter part about the middle indicates that the animalcule propagates by division: this is also evident by the smaller figure, where a division is perceptible: they measure from 1-1000th of an inch in length to 1-100th. They are admirably exhibited by a doublet magnifier of 1-25th of an inch focus. It is worthy of remark, that I have always found it advisable to examine these loricated animalcules without the intervention of mica or glass, for when covered they are rarely seen to move. It is also necessary to observe, that they die if any fresh water be put along with them.

SECOND DIVISION.—PHYTOZOA.

97. *VIBRIO rugula**. *The wrinkled Vibrio*.—This little worm animalcule appears a mere wavy inflexible line, as shewn, greatly magnified, at group 45. It requires a power of near 400 to discover it: its length varies from 1-1200th to 1-400th of an inch. They usually congregate in great numbers, and swim backwards and forwards without altering the inflexions of the body. Found in September, in an infusion containing the *Paramecium aurelia*.

98. *VIBRIO lineola**. *The line Vibrio*.—These are the smallest worm animalcules discovered by the microscope, are always found in masses, and nearly the first kind that make their appearance in vegetable infusions. In warm

weather they are very abundant: length, 1-3600th of an inch. They require a much greater magnifying power than the last, owing to the small diameter of their body.

99. *VIBRIO bacillus*.* *The stick Vibrio*.—This species is rather shorter than the *V. rugula*, and each extremity is abruptly truncated: it is of equal diameter throughout its length. Its motion is languid. Muller found them in an infusion of chopped hay, while in a similar infusion made at the same time, in which the hay was not cut, he found only the *Monas atomas* and the *Kolpoda cucullus*.

100. *VIBRIO spirillum* (*Spirillum volutans*, E.) *The screw Vibrio*.—This interesting microscopic object varies from about 1-2000th to 1-1000th of an inch in length: its form, although simple, is remarkably singular; like a slender wire formed into an helical volute, as shewn, magnified, in group 46. The coils are inflexible, and do not alter during the animal's propulsion, which it accomplishes by winding itself spirally through the water, its extremities vibrating slightly. In some specimens the coils are very close, like the thread of a fine screw; in others, they are more open and separate. The number of coils varies from two to twenty, or more.

This singular little animalcule forms an excellent illustration of the want of a work like the present for general reference, it having been within a few years observed by several individuals, each supposing it a new discovery, as no English book contains the slightest sketch of it,

although it forms such an admirable microscopic object. Found in vegetable infusions.

101. *VIBRIO undula*, (*Spirillum undula*, E.) *The wavy Vibrio*.—This animalcule, like the last species, is inflexible, but the body is simply undulated, and not coiled cylindrically : when at rest, it does not appear so waved as in motion, which probably arises from its celerity, the impression on the retina remaining. It generally resides on the surface of the drop of water, and sometimes fixes itself by one end, and revolves. Leeuwenhoek, whose measurements are generally vague, informs us that its diameter is much less than the tail of the human spermatic animalcule, and adds this remark : “ That as this minute creature, of whose animated existence there can be no doubt, can inflect its extremities at pleasure, we must conclude that tendons and muscles are essential to its existence as in larger animals ; if to these we add alimentary organs, and those of sensation, the mind is lost in the astonishment which arises from the impression of *infinite* in the indefinitely small.”

102. *VIBRIO serpens*. *The serpent Vibrio*.—This species is larger than the two former, and undulated like the last, but the inflexions are regular and uniform ; it generally moves in a direct course. A dark line may be seen running along the body, which is probably its alimentary canal. It is found in river-water, but is scarce.

103. *VIBRIO vermiculus*. *The little worm Vibrio*.—This

animalcule is cylindrical, and of an opal appearance. The anterior part is enlarged and convex, and the body gradually diminishes to the other extremity. It is easily recognized by the several contractions along the body, giving it the appearance of joints. It moves like the common earth-worm, and is very sluggish. When it inflects itself laterally, a dark mark may be seen running along the middle: sometimes this line or alimentary canal is broken, but mostly continuous. Found in marshes in November. Scarce.

104. *VIBRIO intestinum*.—This gelatinous animalcule is of the same milk-white colour as the preceding, and has some resemblance to it, but no contractions have been observed in the body: it is capable of altering its form considerably, especially the fore part, which it can dilate into a broad flat mass, or contract into a taper point: no line is observed down the body, but there are always seen a few bright globules near its posterior extremity.

105. *VIBRIO virminus*. *The worm Vibrio*.—This animalcule consists of a long diaphanous membrane, gradually diminishing towards its anterior extremity: near the middle of the body is occasionally seen two small globules, and one near the posterior; these are, probably, digestive sacs. Two of them are often seen united about the middle of their body, somewhat resembling the Siamese twins. Found in foetid sea-water.

106. *VIBRIO malleus*. *The hammer Vibrio*.—These singular animalcules, which are often found in great

numbers in some clear springs, are very minute, pellucid, and without any apparent internal organization ; their posterior extremity is globose, and the anterior assumes the form of the letter T when at rest, and the letter V when in motion, as exhibited in the two magnified figures, group 47. It is difficult to examine them accurately, as they are incessantly changing their position.

107. *VIBRIO acus*, (*Euglena acus*, E.) *The needle-shaped Vibrio*.—This animalcule resembles the next species (*V. sagitta*), shewn in figure 48 ; but is very slender, the body not being a quarter the diameter of the latter, and the tail drawn out into a delicate thread : it is also distinguished from it by a bright red dot in the head, called by Ehrenberg the eye. (See *Cercaria viridis*, which has a similar spot ; also Book III.) The nature of its alimentary organs has not been demonstrated. A bright line is sometimes seen down the middle of the body, which makes its form apparently triangular ; this, however, is an optical illusion. In progressing through the water, it seldom inflects itself. It propagates by a division lengthways. Found near the surface of stagnant water. Length, 1-480th to 1-200th of an inch.

108. *VIBRIO sagitta*. *The arrow Vibrio*.—This species, which is shewn, magnified, at figure 48, is flexible, and progresses by contracting and elongating its neck : the head is generally dark, and the body appears filled with green molecules. Found in sea-water.

109. *VIBRIO linter*. *The boat-shaped Vibrio*.—This animalcule resembles more in form an egg with a short neck, than a boat. The interior is usually filled with pellucid molecules, indicating a polygastric structure. Found occasionally among duck-weed.

110. *VIBRIO colymbus*. *The diver Vibrio*.—This animalcule, shewn, magnified, in figure 49, is the largest of the genus: its motion is slow. Found in clear river-water.

111. *VIBRIO utriculus*. *The little bottle-shaped Vibrio*.—This species has some resemblance in form to the *Enchelis pupa*, fig. 36. It has commonly a bright globule towards the end, is very restless, and swims in an undulating course. It is met with both in fresh and salt water infusions.

112. *VIBRIO strictus*.—This *Vibrio* is capable of great contraction, as exhibited by the magnified views, figures 50 and 51, where it is shewn both at its greatest contraction and elongation. It seldom inflects itself, and the neck when extended is like a thread, and quite diaphanous. Found in sea-water.

113. *VIBRIO anas*. *The duck-like Vibrio*.—This animalcule resembles the *Trichoda anas*. It is capable of great contraction: the neck is long and not so slender as its posterior extremity; the interior is replete with digestive sacs. Found both in salt and fresh water infusions. Length, 1-280th of an inch.

114. *VIBRIO fasciola* (*Trachelius fasciola*, E.) *The fillet Vibrio*.—This animalcule appears from its organi-

zation to be nearly allied to the *Trichoda anas*, to which the reader is referred. The mouth, which is a longitudinal opening, situated in the neck, is devoid of ciliæ. The polygastric structure of its digestive organ is readily demonstrated: it propagates by division, and just before its separation has a very singular appearance in swimming, which is always rapid. Length, 1-300th of an inch.

115. *VIBRIO olor* (*Lacrymaria olor*, E.) *The swan Vibrio*.—This is a very diverting little animalcule; its quick and lively movements among the confervæ which it inhabits, and the rapidity with which it is continually changing its form, contracting and expanding its long neck, combine to give it an interest not equalled by any of the larger animals. It seldom removes far from the vegetation on which it is found, and is constantly in the search of prey, moving its head with great rapidity, and inflecting the neck into various forms. The magnified views, figures 52 and 53, shew it contracted and extended: in the latter condition I have observed them 1-80th of an inch long. They are found among confervæ and in green stagnant water.

116. *VIBRIO cygnus*. *The cygnet Vibrio*.—This animalcule is smaller than the preceding; the neck is shorter; the extremity not dilated; and its posterior end is more slender. I am inclined to think it is only the infant state of some other species. It is sluggish in its movement. Found in stagnant water.

117. *VIBRIO anser* (*Amphileptus anser*, E.) *The goose*

Vibrio.—This animalcule (figure 54) has generally one or more protuberances on its dorsal surface ; the neck is not very contractile, but longer than the body, which is variously contorted vertically, the contractions indicating that it propagates by division, and therefore should not be taken as a specific character. Under careful examination, ciliæ may be discovered on various parts of the body.

118. *VIBRIO falx* (*Trachelius falx*, E.) *The bent Vibrio*.—This animalcule has a short neck, which is bent and inflexible: the form of the body is elliptical, and rounded at the posterior end. The mouth, which is distinguished with difficulty, is longitudinally disposed on the inferior side of the neck.

119. *VIBRIO intermedius*. *The medium Vibrio*.—This animalcule derives its name from an intermediate resemblance with the last species, and the *Vibrio fasciola*: it is very flat and thin towards its anterior extremity, which it constantly folds in various forms: it has a bright talc-like appearance, and the inside exhibits a number of polygastric sacs. Found in various vegetable infusions.

120. *VIBRIO amblyoxys*, E.—This new species is the 1-600th of an inch long. For its generic characters, see Book III.

THIRD DIVISION.—ENTOZOA.

The following species of Vibriones are excluded from both classes of the Phytozoa, as they possess an alimen-

tary canal, but no cilia, nor occasion currents when immersed in a mechanical solution of coloured particles : they would, therefore, probably be included with the Entozoa. As microscopic objects they are highly interesting, and their organization well worthy of rigid examination.

121. *VIBRIO serpentulus* (*Amblyura*, E.) *The serpent Vibrio*.—This and the succeeding species are distinguished from the paste eel, by a short protuberance on the under side, by which it can attach itself to extraneous bodies by suction. When examined by a good instrument, feelers may also be observed, but they do not occasion currents. It is usually seen coiled in the sketch, fig. 55. By unassisted vision, they appear of a milk-white colour.

122. *VIBRIO gordius*. *The gordian Vibrio*.—The anterior extremity of this cylindrical animalcule is terminated suddenly : the mouth and œsophagus are very pellucid, and the commencement of the alimentary canal is at about one-sixth of the length of the *Vibrio*, where the creature becomes more opaque. The posterior extremity is terminated by a small knob or tubercle. They are generally found coiled, and entangled with each other, in vegetable infusions, either in salt or fresh water.

123. *VIBRIO coluber*. *The snake Vibrio*.—This thread-like animalcule is furnished with a long setaceous tail, which is stiff and inflexible, except at its union with the body, where it can bend it at a considerable angle, as shewn, at its greatest deflexion, figure 56, which re-

presents the animalcule at rest. In swimming, the tail is seldom deflected : the mouth, œsophagus, and alimentary canal, are readily distinguished under a power of 200. Found in river-water.

VIBRIO anguillula.—This name is applied by Muller to the four following species of eel-like animalcules :—

124. *VIBRIO aceti*. *The vinegar Vibrio, or Eels in vinegar*, are thread-like animalcules, found in common vinegar exposed to the air for some time, and become slightly turbid. This species is generally longer than the paste eels, but their diameter considerably less : this circumstance, and the agility of their movements, render it very difficult to discern their internal structure ; yet an alimentary canal has been observed, and it has also been ascertained that they are oviparous at one season and viviparous at another. Some trace of an external process has been seen, probably a sexual organ ; in other respects they so closely resemble the paste eels that it is unnecessary to give a figure of them.

From the experiments of Dr. Power, it appears that a slight elevation of temperature above blood-heat destroys them, while the most intense cold to which he subjected them only produced torpor, although the vinegar was frozen, and become solid : on thawing, they always revived. If the surface of the vinegar is covered with oil, and then frozen, the eels will ascend into the oil during the congelation, and return to the vinegar on assuming a liquid form. If a few drops of sulphuric acid be mixed

with the vinegar, no eels will be found: this is often added by the maker, to prevent mildew.

125. *VIBRIO glutinis* (*Anguillula flaviatilis*, E.) *The paste Eels*.—These interesting microscopic objects are described in the “Microscopic Cabinet,” and illustrated by some magnified drawings by Dr. Goring; I shall therefore only append here some additional observations, and refer the reader to that work for further information.

If you select a number of the full-grown eels, and wash them in clean water, to free them from the glutinous matter of the paste, and then place them in an aquatic-box, or on a stage-glass, under the microscope, with a magnifying power between 200 to 400, the sexual organs may be distinctly recognized when the eels are quiescent. This, as well as their internal organization, will be more readily discerned, if a drop of a mixture of carmine be introduced to them.

One of the most striking peculiarities in the economy of these creatures is, that the female at one season of the year is oviparous, while at another, she is viviparous. (See “Microscopic Cabinet,” Plate 4.) The object of these changes is unknown; but I conceive it probable that the eggs are produced for the continuation of the species through the winter; as we have well authenticated experiments on the eggs of insects, which shew that no ordinary cold injures their vitality, although it may be so intense as to retard the exclusion of the young for several years. Some observers consider the ovipa-

rous eels a distinct species from the viviparous, but this has not been demonstrated ; and I fear microscopic naturalists have too often divided animalcules into distinct species which merely differ in the stage of their growth, thus unnecessarily augmenting the number of names, and creating confusion ; for, surely, if there only existed half the number of species that are well known as distinct, they alone would be fully sufficient to engage the constant attention of any lover of the works of creation, in exploring their structure and economy. It is, however, but common justice to the microscopist to mention, that, although labouring under such immense disadvantages in this department of nature, from the minuteness of his subject, the difficulty of preserving identical specimens from infancy to maturity, and even if he accomplishes this satisfactorily, all his knowledge of them is obtained by one organ only—the eye—and that in an artificial manner, while ornithologists have committed more egregious errors. Thus Gmelin, and some others, have described the same individual, “the Golden Eagle,” (*Aquila chrysaetos*), in different stages of its growth, as four distinct species.

126. *VIBRIO fluvialis*. *The fresh water microscopic Eels*.—These animalcules, which are found in different vegetable infusions, and especially in river water, near the surface, are smaller and more pellucid than the former. Little of their internal organization is known ; but what is ascertained, agrees so much with the paste eels that it is unnecessary to repeat it.

There is another variety, much larger, found in blighted wheat, described by Mr. Needham : they are obtained by opening and immersing in water those blighted grains which are externally covered by a black powder like soot. They are distinguished from the other eels by a row of diaphanous globules disposed along the body, resembling the *Vibrio serpentulus*, and are of a chestnut-brown colour. They are about 1-30th of an inch in length, and therefore only require a low magnifying power to inspect them. (See Sir E. Home's Lectures on Comparative Anatomy, which contain some valuable information on this class of animalcules.)

127. *VIBRIO marina*. *The salt-water Vibrio*.—These eels do not differ in any specific character from the former, but are found in stagnated sea-water. Hence they are not uncommonly procured from oysters, if the water be examined when the fish is removed from the shell. Of course it is necessary to take only such oysters as have not been washed in fresh water. Their length is about 1-40th of an inch. See figure 57.

128. *VIBRIO inflexa* (*Anguillula inflexa*, E.)—New species ; measures in length 1-72d of an inch.

129. *VIBRIO recticauda*, (*Anguillula recticauda*, E.)—This new species is probably allied to, if not indetical with, the *Vibrio coluber*. Length, 1-96th of an inch.

GENUS VI.

CYCLIDIUM.

THIS genus is composed of animalcules of a flat, round, or oval form, without any apparent cilia. Like some others, they are so very diaphanous that the most delicately finished engravings of them afford but a faint idea of their exquisitely brilliant, crystal-like appearance, when viewed under a good Achromatic Microscope of large angular aperture.

130. *CYCLIDIUM bulla. The bubble Cyclidium.*—This animalcule is very diaphanous, and of a circular form. By careful observation, small sacs may be discerned within it. It swims in a graceful serpentine course. Found in an infusion of hay.

131. *CLYCLIDIUM milium. The millet Cyclidium.*—This species is very minute, and, under moderate amplification, appears like millet-seed; but with a deep magnifier its elliptic figure is readily seen, and its brilliant, crystal-like appearance, combined with the variety of its movements, render it a most interesting microscopic object. A few sacs may be seen occasionally in its interior; from the currents it sometimes produces in the water, the body must be furnished with cilia.

132. *CYCLIDIUM glaucoma*. *The azure Cyclidium* is of a flat oval form, as shewn at figure 58. In its usual condition it is pellucid, but when fed with colouring matter, dark spots may be seen, as in the drawing. In swimming, it sometimes rotates, and exhibits its narrow side view; and if the water be filled with opaque particles, a current may be perceived towards the front of it, indicating the presence of cilia, which, however, can only be seen when the animalcule is expiring. (See figures 59 and 60.) These creatures propagate by division, during the progress of which they alter their form. (See figure 61.) They require a magnifying power, from 400 to 800 times to view them distinctly. Length, 1-1400th to 1-1800th of an inch.

133. *CYCLIDIUM scintillans* (*Glaucoma scintillans*, *new genus*, E.) *The glittering pearl Animalcule*, shewn at figures 192 and 193, plate 4, has probably been confounded with the preceding. The body is soft; the mouth is situated on the under side near the centre, and furnished with a strong bristle: when this oscillates, and is viewed from above, it presents the appearance of a pulsatory organ, like the heart. They propagate by transverse division, and probably also by ovæ, as very small specimens are seen among them. Found in stagnant water. Size 1-570th of an inch.

134. *CYCLIDIUM margaritaceum*, E. (*new species*).—This, like the *Cyclidium glaucoma*, is furnished with a cluster of ciliæ on the under part of the anterior extremity. Size, 1-1200th to 1-1500th of an inch.

135. *CYCLIDIUM fluitans*.—This is a bright animalcule, slightly oval, and surrounded by a margin of a blue colour. It is very small, requiring a magnifying power of 400 at least to examine it.

136. *CYCLIDIUM nigricans*.—This is a very small, pellucid, flat, elliptical animalcule, with a dark margin; and under a low magnifier resembles an *Enchelis*.

137. *CYCLIDIUM rostratum*. *The pointed Cyclidium*.—This species is of an oval figure, with its anterior extremity pointed; it is restless, and constantly in search of food; the interior sometimes exhibits a series of dark sacs; at others, faint traces of lines may be discovered.

138. *CYCLIDIUM nucleus*. This oval *Cyclidium* has the posterior acute, resembling grape-seed. It is about twice the size of the *C. nigricans*. Scarce. (See figure 62.)

139. *CYCLIDIUM hyalinum*. *The glass-like Cyclidium*.—This is a very small diaphanous animalcule, like the young of the *C. nigricans*.

140. *CYCLIDIUM pediculus*.—This is a parasitical animalcule, infecting the polype: it is white, with the extremities depressed and truncated; sometimes one extremity appears divided, which is most probably the mouth.

141. *CYCLIDIUM dubium*.—This animalcule is exhibited magnified, in two positions, at figures 63 and 64; the upper surface is convex, and the under concave. It is found among *lemna*.

GENUS VII.

PARAMAECIUM.

THE animalcules included in this genus are membranous, long, and rather flat. Ehrenberg supposes these and the *Kolpoda* to be the same as the *Monads* and *Cyclidia*, at a more advanced stage of their growth.

142. *PARAMAECIUM chrysalis*. — These interesting creatures appear like milk-white specks to the naked eye. They are soft, and yield to the pressure of any hard substance they may come in contact with. The body is long, and in some positions the cuticle appears to have a diagonal fold, as shewn in figure 66. The mouth aperture is situated on the inferior side, near the middle, and in some views it appears like a papillary projection, as seen in figure 67. In good Microscopes the body is seen covered with longitudinal rows of hair: by means of these, the creature is enabled to produce a current in the water towards its mouth. They propagate by transverse division.

These animalcules are well adapted for exhibiting the structure of the alimentary organs, as they are of sufficient magnitude to render the sacs clearly perceptible, when filled with coloured particles. On the introduction of

indigo into the water they are greatly agitated; in a few minutes, however, they are quiet, and the digestive sacs become coloured, as in the drawing, when from 100 to 200 may be enumerated. Length, 1-85th to 1-200th of an inch. (See Book III.)

143. *PARAMAECIUM aurelia*.—This animalcule has so strong a resemblance to the preceding one, that it is unnecessary to notice it further, than by stating, that its extremities are more pointed. (See figure 68.) Size, 1-200th of an inch.

144. *PARAMAECIUM compressum*, E.—1-200th long; new species.

45. ————— *ovatum*, E.—1-280th long; new species.

146. ————— *versutum*.—"Cylindrical animalcule, the lower part thick, both extremities obtuse;" it is often of a green colour.

147. *PARAMAECIUM oviferum*.—This creature has its interior filled with large egg-shaped molecules. Figure 69 represents one undergoing division.

148. *PARAMAECIUM marginatum*.—This large species is the shortest of the genus in proportion to its breadth. Figure 70 shews it magnified, with its pellucid margin.

GENUS VIII.

K O L P O D A.

THIS genus is thus defined by Muller : “An invisible, very simple, pellucid, flat, crooked animalcule.” They vary much in external form ; but figures 80 and 89 will give a general idea of the genus. (See Book III.)

149. *KOLPODA lamella* (*Trachelius lamella*, E.) *The laminated Kolpoda*, shewn at figure 72, is a thin, long, membraneous animalcule, having its anterior extremity curved ; its resemblance generally to the other species of this genus is slight. The mouth is placed longitudinally on the inferior side of the body, and is recognized with difficulty. It has a peculiar undulatory motion, often progressing on one of its edges. Scarce.

150. *KOLPODA gallinula*. *The pullet Kolpoda*.—This animalcule is somewhat egg-shaped, with its apex slightly bent ; it is very transparent, although its posterior is often filled with semi-opaque matter. Found in salt-water.

151. *KOLPODA rostrum* (*Loxodes rostrum*, E.) *The hooked Kolpoda*.—This is an oblong animalcule, with the fore part bent like a hook, and the hind part rounded :

it has also one of its edges from the back to the middle often dilated, giving the anterior part of the *Kolpoda* a triangular form. Its motion is slow. Found among *lemna*. Rather scarce.

152. *KOLPODA ochrea*. *The boot-shaped Kolpoda*.—This is the largest species of the genus: it is flat, and capable of inflecting itself. Figure 74 shews it magnified: the mouth is situated near the cross: sometimes the anterior extremity is almost straight; then the animalcule has some resemblance to a boot.

153. *KOLPODA mucronata*. *The pointed Kolpoda*.—This creature is flat, and has a strong resemblance to the *Kolpoda cucullulus*; see figure 89. It is surrounded, as that figure indicates, by a diaphanous margin, and the interior is occupied by digestive sacs.

154. *KOLPODA triquetra*. *The triangular Kolpoda*.—This species is somewhat egg-shaped, the mouth being situated at the larger extremity, which is flattened and furnished with ciliæ. Found in salt-water. Scarce.

155. *KOLPODA striata*. *The striped Kolpoda*.—This animalcule is in the form of a pear slightly curved, the anterior part being pointed and furnished with a small vesicle. It is very pellucid, and when highly magnified appears covered with longitudinal stripes. Globular sacs may be discerned within it. Found in sea-water.

156. *KOLPODA nucleus*.—This is certainly the young of the *Kolpoda cucullus*. (See figure 77.) Found in an infusion of hemp-seed.

157. *KOLPODA meleagris* (*Amphileptus meleagris*, E.)

—*The turkey-hen Kolpoda* is larger than the preceding species: it assumes a variety of curious and diverting forms. Its most common appearance is shewn at figure 73. It sometimes contracts itself into a flat and nearly circular mass, with the margin curiously indentated, and the surface variously folded; at other times it stretches itself, and displays, under the microscope, a series of longitudinal stripes along the body; then, again, it is metamorphosed into the form of figure 75, having its posterior extremity in the form of a hammer. Under a good instrument, with the assistance of finely-divided colouring matter, the body may be observed covered with hair, and the form of its alimentary organs demonstrated. It propagates by spawn, during the casting of which the posterior position of the parent is dissipated. They are found among healthy duck-weed, under which they often retire, and elude the search of the microscopist. By placing several discs of the *lemna* on a stage-glass, and examining them one by one under a low magnifier, they may be readily found, though they are seldom very abundant.

158. *KOLPODA assimilis.* *The notched Kolpoda.*—This is a short, pear-shaped animalcule, with the pointed extremity bent, and the concave side notched. The alimentary sacs are generally disposed near one side of the body, and arranged in an elliptical cluster: the posterior is suddenly pointed. Found in sea water.

159. *KOLPODA cucullus.* *The cuckoo Kolpoda, or common bosom Animalcule.*—This singular creature, as it

advances in growth, alters its form so entirely, that even by an observer well acquainted with other mature animalcules, the young cannot be identified; for although its peculiar form renders it easy to be distinguished when full grown, yet the infant specimen may be readily mistaken for a *Monad*. This circumstance cannot be too strongly noticed; for unless we are constantly on our guard we shall often be led to consider the same animalcules at different stages of their growth as so many distinct species. But in order to illustrate this point more fully, I shall refer to a series of figures, by Dr. Ehrenberg, representing this animalcule in its various states of development, to give the reader a clear idea of its characters. The drawings are all magnified 380 times linear.

The normal form of this species, when fully developed, is shewn at figure 80. Its general contour has some resemblance to a bean; and if we suppose the two convex lobes on the front side equal, and do not perceive the proboscis, which indeed is seen with difficulty, we shall distinguish some likeness to the bosom; from which similitude it has received its name. The mouth, which is lighter tinted than the surrounding parts, is situated in the hollow between the upper lobe and the proboscis, and marked by a cross, while the termination of the alimentary canal is in the cavity immediately below the proboscis. The margin of the two lobes, as shewn in the drawing, is furnished with a row of delicate cilia, only observable under favourable illumination. These cilia, by producing a current in the water towards the mouth,

perform the same important office as members in some of the mammalia ; as the current brings all the particles of matter in the water to the mouth in regular succession. Thus the little animal, by this admirable design of its all-wise Creator, is enabled to enjoy the choice of its food with as much facility and comfort as the larger animals, refusing such as does not suit its taste, and feeding on that which is more agreeable to it.

By feeding them on vegetable colouring matter, the polygastric form of their digestive organs is readily distinguished ; two spherical cavities are shewn in the drawing as filled with opaque matter, and others diaphanous.

Having given the reader a full account of the mature animalcule, I shall proceed to its mode of propagation. A short time after it has arrived at the form figure 80 in the drawing, it assumes the form figure 79, which represents the same animalcule in the act of casting its spawn, which consists of a loose mass slightly cohering by fine filaments like net-work, as shewn below the parent, in the drawing. The form of the two lobes then becomes very dissimilar and much distorted, as shewn, by the drawing of the same animalcule, at figure 81. It, however, continues to swim about briskly with the others, and whirls like them without any apparent inconvenience. Similar changes in form ensue after each successive spawning, till at last there is little left of the original creature but the anterior lobe, which is diminished in size.

The spawn remains some time before it exhibits any symptoms of life ; but as soon as it does, and the young

issue from it, they have so strong a resemblance to the genus *Monas*, that they cannot be distinguished. When they arrive at the size shewn by figures 76, 82, and 83, or at about 1-1700th of an inch in length, their further development may be distinctly traced. In figure 76, the creature has just assumed an elliptical form; when younger it was probably more spherical: at this period of its growth no cilia are to be observed, except when the water has almost evaporated: in figure 82, which is a side view, these become visible, and the creature is seen creeping along a small piece of partially decomposed vegetable: after this it rapidly increases in size, and the front becomes concave, as shewn in figure 83. The lobes next appear, and then their fringe of cilia, while the back becomes more convex: the animalcule has then nearly arrived at maturity, only wanting the smooth proboscis, as shewn in figure 80. Thus we complete the cycle of development; which is as definite and constant as in any of the larger animals.

Length of full-grown specimens, 1-280th of an inch. They are found in various vegetable infusions, and especially in those of hay which have been kept a considerable time.

160. *KOLPODA cucullulus* (*Loxodes cucullulus*, E.) *The hood-shaped Kolpoda*.—A full-grown specimen of this beautiful species is shewn, magnified 380 times, at figure 89. Its body is devoid of cilia, excepting the parts adjacent the mouth, which are furnished with a row of delicate hairs; by these the creature procures its food.

The mouth is situated in the concavity marked by the dotted line and cross. The tissue which envelopes the animalcule is transparent and colourless, covering all the integuments of the body except at the lower extremity. Its digestive organs are polygastric, consisting of numerous spherical cavities or sacs, branching out from the alimentary tube ; these are capable of great dilatation, which is rendered peculiarly manifest after it has swallowed a *Navicula ulna*, as shewn in the drawing. They are very persevering in search of their prey, examining every thing within their reach in the most scrutinizing manner. They creep along, and swim in the manner shewn by the group of young ones attached to two pieces of confervæ, figure 86. At other times, when their food is floating in the water, they remain stationary, and create a current towards them by the cilia, as in figure 85.

For the increase and continuance of the species, the parent animalcule is separated, either vertically, longitudinally, or obliquely. These different modes of propagation seem to be indeterminate, it having never been ascertained whether the longitudinal, vertical, or other division, are the result of particular circumstances. To afford the reader an idea of their appearance while undergoing division, I have given two figures from Ehrenberg, which, like the others, are magnified 380 times. The first, figure 88, exhibits an animalcule undergoing a transverse section ; and figure 87, another about to be divided longitudinally. They are found in various in-

fusions during the summer. Length, from 1-400th to 1-900th of an inch.

161. *KOLPODA cuculio* (*Loxodes cuculio*, E.) *The tongue-shaped Kolpoda*.—This animalcule is often found on the under side of *lemna*, along with the *Paramaecium aurelia* and the common *wheel* animalcule: it is capable of great elongation, thrusting out the anterior part like a tongue, which it sometimes bends in various forms; at other times it creeps along the duck-weed contracted; its middle rising into convex forms, with the edges inflexed, like a bonnet or hat; then again it assumes the forms shewn at figure 90, with a large spherical sac in the middle. It is generally smaller than the preceding species, averaging from 1-800th to 1-900th of an inch in length, in the medium state of contraction.

162. *KOLPODA ren*. *The kidney-shaped Kolpoda*.—This species and the *Cucullus* are the only two admitted by Ehrenberg into his genus *Kolpoda*, which he mainly distinguished by a short proboscis, and body partially covered with hair. It is of a yellow colour, slightly bent in the middle, and has a strong resemblance in contour to a bean, with its two lobes unequal: the gastric sacs are numerous. From Muller's observation, it appears to propagate by a transverse division into two parts; but the history of this creature, like many others, requires further research before its economy can be correctly ascertained. They are found in vegetable infusions, and are often the first that appear in an infusion of hay. They measure from 1-250th to 1-300th of an inch.

163. *KOLPODA pirum*. (*Trichoda carnium*, E.) *The pear-shaped Kolpoda*.—This delicate animalcule is represented, magnified, at figure 84. The body is slightly curved, and the anterior extremity rather pointed. The specimen shewn in the drawing is about to separate, and a colourless line or band may be perceived across the middle of the body. This is usually observable before the contraction of the body, and is the first indication of a division: when completed, the two animalcules thus produced are much shorter in proportion to their breadth than the parent; indeed, some of them, when just apart, are so nearly globular, that at the first glance they might be mistaken for a species of *Volvox*. In the drawing may be seen the cilia surrounding the mouth; these, as remarked before, are very difficult to be discerned; they require a good microscope, and considerable address in the observer, to render them distinct: the direction of the current which the cilia produce is marked by the arrows: the polygastric form of the alimentary canal, and its termination at the lower extremity, are shewn. When the water has nearly evaporated, longitudinal folds may be observed along the body, and when completely dried up, the cilia become more distinct. Ehrenberg considers that, according to Muller's arrangement, it ought to be placed along with the *Paramaecium*. Size, 1-400th of an inch. (See figures 77 and 78.)

164. *KOLPODA cuneus*. *The wedge-shaped Kolpoda*.—This animalcule is shewn in two of its most common forms, at figures 91 and 92: it somewhat resembles a

quince, having the larger or anterior extremity dentated, as shewn by the cross. Sometimes, as in figure 91, a large bright pustule is observed; at others, this is wanting. The posterior extremity is capable of expansion, and of being flattened out like a wedge, or bent in a spiral form, at the pleasure of the animalcule. It is nearly twice the size of the last species, and of a milk-white or grey colour.

GENUS IX.

G O N I U M.

THE animalcules of this genus are in clusters ; they are propagated by several incisions across the body of the parent, dividing it into a number of symmetrical forms. When observed singly, most of the species resemble the genus Volvox. The structure of their digestive organs is unknown : as microscopic objects, they are very pleasing and entertaining, and only require a moderate power for their examination. In the Achromatic and Jewel Microscopes their bright and transparent colours are beautifully exhibited, and by the employment of *intense* illumination, moderated in quantity by diaphragms, as described in the “ Microscopic Cabinet,” their forms, change, colour, and motions, may be observed with ease. Muller defined this genus as composed of “ invisible, simple, smooth, angular animalcules.”

165. *GONIUM pectorale*. *The breast-plate Gonium*.—The form of this animalcule, or, more correctly, cluster of animalcules, is shewn at figure 93. It consists of sixteen spherical bodies, disposed regularly in a quadrangular form, like the jewels in the breast-plate of the Jewish High Priest. They are all arranged in the same

plane ; the four centre ones are generally larger than those which surround them ; and the diameters of the three smaller balls are only equal to the two larger centre ones to which they are attached ; the external corners are consequently vacant. As these animalcules swim and revolve in the water, they occasionally present a side-view to the observer, when the circumference of the larger central globules may be seen projecting beyond the others. Sometimes the cluster appears irregular, as shewn in figure 95 : this happens when the larger animalcules have arrived at maturity, and some of them are separated from the cluster. When they are all of equal diameters, the group divides across the middle, both vertically and horizontally, and separates into four clusters, each consisting of four animalcules. As soon as a cluster has separated, the respective animalcules increase in size, and in a short time their surfaces appear decussated, and they severally begin to form into regular clusters, like the original one to which they belonged. They are of a beautiful transparent green colour, and in swimming the globules often appear of an ellipsoidal figure : their forms are so simple, and so different from animated beings visible to ordinary vision, that it would be difficult to bring our reason to admit of their vitality, were not their spontaneous motion clearly ascertained. The diameters of the clusters vary from 1-350th to 1-200th of an inch. Some fine specimens I have seen even larger ; hence the average size of an individual globule is about 1-1200th of an inch. They are found near the surface of

clear water, and often along with the *Cercaria viridis*. A magnifying power of 200 is sufficient for their examination.

166. *GONIUM pulvinatum*. *The bolster-shape Gonium*.—When young, this animalcule is merely a simple, flat, quadrangular membrane, with the corners sometimes projecting like a pincushion. The surface in a short time becomes indented, and the square appears like three or four bolsters or pillows attached side to side : other markings are soon observed at right angles to the first, forming the mass into small squares, as represented in figure 97. These smaller squares, when sufficiently matured, separate, and soon form into clusters, like the parent one. It sometimes happens that while the animalcule is merely divided into pillows, before the smaller squares are formed, it increases in length, and a single line is observed across the middle, presenting the appearance of two squares of four pillows each, attached by their ends. They swim about much in the manner of the last species.

167. *GONIUM trichina*. *The bristled Gonium*.—This species has not been hitherto described. It is of a bright green colour, and composed of four pillow-shaped bodies, each corner of the cluster being furnished with a single strong bristle, as shewn, greatly magnified, at figure 96. When arrived at maturity, the cluster separates, sometimes in twain, forming two new ones, consisting of two pillows each : when this happens, bristles are soon produced at the two corners which before united the for-

mer cluster, and the animalcule swims about, increasing in width till it finally extends itself to four pillows. Another method of propagation is by cross divisions, forming the mass into squares, like the *Gonium pulvinatum*. An indication of a transverse division is shewn in the figure by the light line along the middle.

The motion of this species is slow, and it often remains quiescent for some time after it has been disturbed. Their method of locomotion is best observed without covering them with mica or glass. They are very small, and require a deep magnifier to examine them. I employed a power of 500 times. The breadth of the cluster drawn in figure 96 was 1-1100th of an inch: hence the diameter of each pillow must be about 1-4400th of an inch. Found in June among healthy confervæ in clear water.

168. *GONIUM corrugatum*. *The wrinkled Gonium* is found in various infusions, and especially in those of fruit, as the pulp of the pear. It is very minute, and slightly depressed at one end; streaks may also be discerned along the body. Figure 98 represents two specimens magnified.

169. *GONIUM truncatum*, vel *obtusangulum*. *The truncated Gonium*.—This animalcule is much larger than the former; it is flat, and of a triangular form, as shewn in figure 94. Found in clear water. Scarce.

170. *GONIUM rectangulum*. *The square-angled Gonium*.—This species only differs from the preceding one in its greater length, and in having the lower corner a right

angle. It is of a green colour, with a few diaphanous sacs.

171. GONIUM *hyalinum*, E. *The crystal Gonium*.—
(New species.) This and the breast-plate Gonium are the only two species admitted into this genus by Ehrenberg. Size of cluster, 1-2000th of an inch.

GENUS X.

B U R S A R I A.

“A SIMPLE, hollow, membranous animalcule,” which takes its name from its bag or purse-like form. Ehrenberg has only noticed one species, and has not decided as to the situation of the genus.

172. BURSARIA *truncatella*. *The truncated Bursaria*.—

This animalcule is discernible by unassisted vision, when it appears of a milk-white hue: the diameter of some fine specimens which I measured was 1-50th of an inch. Its form is shewn at figure 99, the cross denoting the mouth-aperture of the bag-like membrane. At the posterior extremity may be seen several small globular bodies: these were considered to be ova by Muller; but as I have seen this animalcule swallow the smaller species of the *Volvox*, and also the *Gonium pectorale*, I feel assured he must be mistaken. In swimming they sometimes revolve, at others they move alternately from one side to the other, in constant search of prey.

173. BURSARIA *bullina*. *The bubble Bursaria*.—This species is shewn at figure 100, slightly magnified; it has some resemblance in form to a boat. It is pellucid, and

its anterior is occasionally occupied with several very small glass-like sphericals. Found in sea-water.

174. *BURSARIA hyrundinella*. *The little swallow-like Bursaria*.—The form of this animalcule, by a little effort of imagination, may be compared to a bird, and its movements appear like the flight of the swallow: hence its name. It is smaller than the two preceding species. A magnified view of it is shewn at figure 101. It is found in stagnant water.

175. *BURSARIA duplella*. *The folded Bursaria*.—This species is rather scarce, concealing itself under duckweed. It is a hollow membrane, folded, as shewn in figure 116, with an opening left between the edges the entire length of the animalcule.

176. *BURSARIA globina*. *The globular Bursaria*.—This animalcule is of a globular form: the interior is sometimes occupied by dark spherules; in other specimens longitudinal markings may be discerned on the body, as shewn at figure 117.

GENUS XI.

C E R C A R I A.

AN “invisible pellucid animalcule, with a tail.” If we consider the internal organization of this genus, it comprehends a very wide range ; indeed, the different species vary so much that it is difficult to give a general definition of their characters with any degree of accuracy.

177. *CERCARIA inquieta*. *The agitated Cercaria*.—The body of this animalcule is capable of being contracted into a globular mass, and at other times of being elongated (as shewn in fig. 103), when two small dots, or eye-like appearances, may be discerned ; occasionally there is seen a large circular marking near the tail, which is in constant motion, vibrating and inflecting itself in various ways. It is found in salt-water, and is just visible with the naked eye.

178. *CERCARIA gyrimus*. *The whirling Cercaria*.—This animalcule is very small, of a white colour, and globular form, with a flexible tail, which is in rapid motion. In swimming it resembles the tadpole. It is very similar to the *C. inquieta*, but smaller. Found in infusions of animal substances.

179. *CERCARIA gibba*. *The hunch-back Cercaria*.—

This species is white, and about the size of the last ; the body is elliptical, the tail short and pointed. Found in infusions of hay.

180. *CERCARIA lemna. The duck-weed Cercaria.*—The body of this animalcule is capable of being contracted ; but its most usual form is shewn in figure 102. Towards the anterior part two small dots may be discovered ; these are considered to be the eyes. The external membrane of the body is corrugated, and the tail divided into rings in a very curious manner, near to which is a short proboscis, which it can stretch out to about half the diameter of its body : it is situated on the inferior side ; hence some persons have supposed it to be within the body. In creeping, I have observed the creature first to attach its mouth to the glass on which it is placed, then contract its body up towards its mouth, like a leech ; it then fixes the hollow part of its proboscis to the glass, in such a manner as to keep it in the advanced position it has attained, until the head can be set at liberty, and extended to perform a similar operation. During the progression the tail is free. I first discovered it in the month of August, among some healthy confervæ in a spring near Hampstead : it was very lively, swimming and inflecting its tail briskly. The body measured 1-50th of an inch in length. They appear to have a true alimentary canal, not polygastric ; but as they escaped before I completed my observations, I could not determine whether they belong to the *Rotatoria*, not having discovered any cilia.

181. *CERCARIA turbo*. *The restless Cercaria*.—This species is shewn at figure 104 : the body is slightly contracted near the middle, and is filled with spherical sacs ; small eye-like dots may be observed, also, near the anterior ; the tail is setaceous. Found among duck-weed on the surface of clear water. Length of body, in some specimens which I procured in December among confervæ, 1-400th of an inch.

182. *CERCARIA podura* (*Ichthyidium podura*, E.) *The podura Cercaria*.—This animalcule belongs to the first genus of the *Rotatoria* ; it produces a slight whirl in the water, and forms a very good test of the excellency of a microscope, a row of cilia being just discernible with careful management. Its general appearance, under an ordinary magnifier, is shewn at figure 114. The body is spindle-shaped, the head obtusely rounded, and the tail forked. It is transparent about the extremities, and sometimes fine cilia may be discerned on either side of the body : in its interior may be seen the peristaltic action of the alimentary canal. In progressing, it slowly revolves, the setaceous tail sometimes appearing single. It is found at the close of the year in marshes, among *lemna*.

183. *CERCARIA viridis* (*Euglena viridis*, E.) *The green Cercaria*.—This is a highly-interesting creature : the bright green colour of its body ; its diaphanous extremities ; its well-defined orange-brown eye ; and the numerous transformations of its form, render it a very entertaining object for the microscope ; in addition to

which it is easily procured, and managed with great facility.

Collect, in a large wide-mouthed phial, some of the matter from the surface of such stagnant ponds as are covered with a dull-green substance, which, at a distance, may be mistaken for *confervæ*, or duck-weed, but which is easily distinguished from it, on a closer examination, by the masses not being connected by fibres or threads, but loose, like dust. This matter, with some of the water of the pond, must be carefully carried, for the least agitation will cause it to sink to the bottom, and kill many of the animalcules, while the rest will be some days before they re-ascend. If a portion of it is placed on the stage-glass under the microscope, it will be found to consist of an immense number of beautiful green animalcules of different shades of colour, from a bright yellow-green to a deep blue-green. If your microscope has sufficient penetrating power, and is free from aberration, you will perceive in the pellucid part of the head a bright orange-brown spot, as shewn in the drawing, figures 105 to 109: this spot, which is the eye of the creature, is situated on one side, just under the surface of the envelope. The most usual, or what perhaps may be called the normal form of this creature, is shewn at figure 107, where is also exhibited by the arrows the direction of the currents produced by the cilia at the mouth. The general aspect of the body is very accurately shewn in this figure, several parts of which are covered with opaque green spots; the centre is often

more transparent, which indicates that the animalcule is about to divide. The tail in this species is merely a gradual diminution of the body: Muller has shewn it as being forked, but I have not detected any division, although I have examined it under very excellent magnifiers: it is probably an optical illusion, caused by its vibration. The body is very flexible, and capable of contracting into a globular mass, as shewn in figure 106. In this form it revolves in the water, and is about 1-1000th of an inch in diameter, and might be easily mistaken for a species of the Volvox, some of which are generally found in the same drop of water, especially the orange-coloured, which are about the same size; as also the *Monas pulvisculus*, and the green spindle animalcule, (*Astasia euchlora*, E.) Sometimes it withdraws its tail, as shewn at figure 109, and often swims about in a slow and graceful manner, with only its body contracted, as shewn at figure 105. In all their forms, except the globular, which they invariably assume when the water has nearly evaporated, these animalcules are very restless, swimming about near the edges of the water.

Whether the alimentary structure of this animalcule is polygastric has not been demonstrated, from the difficulty there is to make it take coloured food; which remark is applicable to all animalcules of this colour. It propagates by division, and from the minuteness of some of the young, compared with the larger ones, it is probable they are also produced from ova.

It may be useful to mention, that if by accident they

are shaken to the bottom of the water, they will rise more rapidly, if the phial containing them be placed near the light; and also that no *Entomostracea**, or *larva*, especially those of the gnat, should be kept in the same reservoir, as the latter will destroy them.

The length of the specimens which I have examined was about 1-350th of an inch: Ehrenberg gives 1-280th as their length. They are most numerous in spring and summer. The magnifying power best adapted for viewing them, is from 300 to 500 times, in an achromatic; with the latter power, the long cilia of the mouth may be distinctly recognized.

184. *CERCARIA rubrum*. *The red Cercaria*.—The animalcules of this species, which is new, I discovered in September, along with the green *Cercaria*, from which they do not differ except in colour, and in being rather larger, with the cilia at the mouth more distinct; they change their form like the green ones, and often assume a funnel shape, the base of the cone being hollow. The eye is very distinct, and of a light brown, the body being of a rich garnet colour. They propagate by a longitudinal division, for I have observed some of them with the two heads distinctly separated.

185. *CERCARIA spirogyra*. (*Euglena spirogyra*, E.) *The spiral-dotted Cercaria*.—This is also a new species, of a green colour, with a circular body, but which it can flatten at pleasure: two views of it, magnified, are shewn

* See "Microscopic Cabinet," page 83.

at figures 110 and 111, in which may be seen the spiral rows of dots : within it are also some larger bodies, probably stomachs. The aperture of the mouth may be discerned, and the currents it produces are indicated by the arrows in figure 111. Length, 1-240th of an inch.

186. *CERCARIA pleuronectes* (*Euglena pleuronectes*, E.)
The plaice-shaped Cercaria.—There are two varieties of this species, mainly distinguished by their colour. The first is green, very flat, and in form like a turbot or plaice : as it can produce currents in the water, the mouth must be furnished with cilia : its bright pink eye is situated rather lower than in the *C. viridis*, and its tail is abruptly attached to the body. In its interior may be observed two or three large diaphanous bladder-like bodies, which, as they vary in different specimens, are probably stomachs : those sacs which have been filled with colouring matter, are always apparently smaller, but this food it appears to dislike, and endeavours to avoid. Until, therefore, we can procure some coloured substance better suited to its taste, the true form of the alimentary organs cannot be demonstrated, although its polygastric structure is almost certain. Like that class of animalcules, it propagates by division : this I have observed to commence longitudinally ; and when the two heads are completed, and the eyes formed, the animalcule has a very singular appearance, swimming about slowly with a uniform motion, and enabling the observer to follow it easily with the microscope. Ehrenberg supposes it also to proceed from the egg, as he met with some very

small specimens. Figures 112 and 113 exhibit a side and edge view of this animalcule, and figure 122, a specimen nearly divided.

The second, or white variety, described by Muller, is of the same form as the green, except at the anterior extremity: he observed two dark spots, like eyes, but very minute. Found near the surface of stagnant water, and among confervæ. Length, 1-560th of an inch.

187. *CERCARIA longicauda*. (*Euglena longicauda*, E.) *The long-tail eye Cercaria*.—This is a new species: it is flat, like the last, of a bright green colour, with a red eye. The tail is nearly the same length as the body, which is very flexible, as it sometimes swims twisted like a screw-driver. Length, 1-200th of an inch.

188. *CERCARIA setifera*. *The bristled Cercaria*.—This is a very scarce animalcule; it is found in impure salt-water, and is smaller than the green *Cercaria*: the body is spindle-shaped, the head terminated obtusely, and the tail short and pointed, near to which a row of cilia, or bristles, may be discerned. In swimming the body slowly revolves.

189. *CERCARIA hirta*. *The hairy Cercaria*.—This is a very remarkable animalcule, rather opaque, and of the form shewn at figure 115, with its posterior extremity furnished with two strong, short bristles. The body is rough, and apparently covered with short hair at regular intervals. In swimming, it revolves on its longer axis, and resembles a wicker-basket: it is generally restless, and difficult to follow except while feeding, when it remains

stationary. I have met with it in various infusions among the *Cyclidia* and *Cercaria viridis*, and also in salt-water; but it is rather scarce. Length, 1-350th of an inch.

190. *CERCARIA tripes* is a very singularly-formed animalcule: its body is flat, and of a triangular shape, with the mouth situated at the base. It is found in infusions, but is scarce. A magnified view of it is shewn at figure 118.

191. *CERCARIA tenax*.—This is a very minute animalcule, not much larger than the *Monas atomus*; very diaphanous; of an oval form, with the posterior part slightly elongated, forming a short, pointed tail. It whirls about with great velocity.

192. *CERCARIA cyclidium*. *The round Cercaria*.—This is larger than the last; slightly oval, with the margin rather darker than the centre: its tail is very short, and is only observed in certain positions of the creature. It is found in clear river-water.

193. *CERCARIA orbis*. *The orbicular Cercaria*.—This is shewn at figure 120. It is circular, with the tail formed of two long setaceous hairs on one side, and on the opposite is situated the mouth. It is found in summer among *lemna*, and is an interesting microscopic object.

194. *CERCARIA discus*. *The plate-shaped Cercaria*.—This is a very small animalcule, rather less than the round *Cercaria*, with a short, curved tail. Found in stagnant water.

195. *CERCARIA luna*. *The moon-shaped Cercaria*.—

This is shewn, magnified, at figure 121. The mouth is situated near the cross, and is capable of assuming a convex form, like the *Cercaria orbis*. Found among duck-weed in summer.

196. *CERCARIA crumena*. *The bag-shaped Cercaria*.—This is a highly-organized animalcule, and probably belongs to the class *Rotatoria*, but no wheels have been observed : it has a true alimentary canal, not polygastric. Its form is shewn at figure 123, where the heart-shaped body indicates the bulb, or commencement of the œsophagus. It is capable of contracting the head into a conical form. The tail is divided at its extremity.

197. *CERCARIA catellus*. *The puppy Cercaria*.—This species I have not examined. Muller found it in stagnant water in marshes. The head is united to the body by an annular contraction ; it has a double setaceous tail, and the body is capable of being contracted. It is about half the size of the last species.

198. *CERCARIA catelina* (*Diglena catel*. E.)—This creature, like the preceding two, belongs to the *Rotatoria* : its generic characters are given in Book III. It is about 1-240th of an inch in length : it has two eyes ; whence its name *Diglena* : the tail, which is forked, is short.

199. *CERCARIA lupus* (*Cycloglena lupus*, E.)—This species, a sketch of which is shewn at figure 124, is distinguished by a number of minute dots circularly disposed, and called, by Elhrenberg, eyes : its muscular

appearance is like the wheel animalcule, and on careful examination cilia may be discerned : it is twice the size of the *C. catelina*.

200. *CERCARIA vermicularis*. *The worm-like Cercaria*.—This is a long cylindrical animalcule, with a proboscis, which it can extend or withdraw at pleasure. The body has several contractions, dividing it into annuli, and the tail is terminated by two bristles. It resembles the next species.

201. *CERCARIA forcipata* (*Distemma forc. E.*) *The double-hooked Cercaria*.—A sketch of this animalcule, magnified, is shewn at figure 119. (See Book III.)

GENUS XII.

LEUCOPHRYS.

DIAPHANOUS, CILIATED ANIMALCULES.

202. *LEUCOPHRYS constrictor*.—This animalcule is globular, and resembles the *Volvox globator* (37) : it is of a yellow colour, with its interior filled with several small vesicles, which are generally in a state of agitation. When the water is disturbed or nearly evaporated, the body appears covered with short delicate hair, and the creature becomes elongated ; it seldom swims, but turns round, first to the right and then to the left, and so proceeds in a zig-zag course.

203. *LEUCOPHRYS mamilla*. *The nipple Leucophrys*.—This animalcule is drawn at figure 128 ; it is spherical, and rather opaque: the mouth resembles a papillary projection, which it can withdraw at pleasure. Found in standing water in marshes.

204. *LEUCOPHRYS viriscens*. *The dull green Leucophrys* is rather larger than the next species ; its form is shewn at figure 127. The body can be elongated or contracted at pleasure ; it is covered with hair ; in its interior may be observed polygastric sacs ; it swims in a direct course. Found in sea-water.

205. *LEUCOPHRYS viridis*. *The green Leucophrys*.—This is of the same form as the last; it is covered with hair, and does not alter the shape of its body.

206. *LEUCOPHRYS bursata*. *The purse-shaped Leucophrys*.—This is shewn, magnified, at figure 126. The mouth is wide, and furnished with clusters of long hair. Found in salt water.

207. *LEUCOPHRYS postuma*.—This animalcule, which is shewn at figure 129, is globular: it appears covered with a transparent net, which may arise from a peculiar disposition of the hair.

208. *LEUCOPHRYS aurea*.—This species is of a yellow colour, slightly ellipsoidal, and covered with delicate cilia barely discernible; its movements are rapid, and it revolves as it proceeds.

209. *LEUCOPHRYS pertusa*. *The pierced Leucophrys*.—This animalcule is shewn at figure 125; it is remarkable from the hollow pierced in the side near the posterior.

210. *LEUCOPHRYS fracta*. *The broken Leucophrys*.—This animalcule is flat, and changes its form; it is covered with hair, as shewn, magnified, at figure 130. Found in stagnant water.

211. *LEUCOPHRYS dilatata*. *The dilated Leucophrys*.—Changeable animalcule, with sinuous edges; it is usually of an irregular oblong form, but sometimes triangular, with the sides concave, and the angles truncated. Filled with grey molecules.

212. *LEUCOPHRYS scintillans*. *The sparkling Leucophrys* is a green animalcule of an egg-shape; it revolves,

and strongly resembles a species of the genus *Volvor*, but from its bright scintillating appearance, arising most likely from the motion of cilia, it is distinguished from it. Found among the *lemna minor* in December.

213. *LEUCOPHRYS vesiculifera*. This animalcule is more globular than the last species, and very diaphanous; the middle often assumes a blue tint, and its interior is marked by a number of pellucid sacs; the body, according to Spallanzani, is covered with hair. Found in vegetable infusions.

214. *LEUCOPHRYS globulifera*. This is probably the same animalcule as the last, at a different stage of its growth: its form is similar to that, but the cilia which cover the body are more distinct: only two or three sacs are visible. Found among the *lemna minor*.

215. *LEUCOPHRYS pustulata*.—This animalcule is more elongated than the two last: the lower end abruptly truncated; it is of a white colour, granulated, and covered with erect cilia.

216. *LEUCOPHRYS turbinata*.—This species resembles in form an acorn without the husk, the mouth being at the base of the nut; the body is slightly contracted about the middle, and covered with hair.

217. *LEUCOPHRYS acuta*. *The pointed Leucophrys*.—This animalcule is capable of contracting its body into a globular mass, as shewn at figure 132: it is of a yellow colour, covered with hair, and has sometimes a small projection on one side, as shewn in figure 133. Found in sea water.

218. *LEUCOPHRYS notata*.—This is a long animalcule covered with cilia ; the mouth-aperture is a longitudinal opening near the anterior extremity, close to which a dark spot may be discerned at the upper edge.

219. *LEUCOPHRYS candida*. *The shining Leucophrys*.—This is a very diaphanous, thin membrane, in form resembling the *Kolpoda lamella* (figure 72), with the edges ciliated. Found in a vegetable infusion in salt-water.

220. *LEUCOPHRYS nodulata* is shewn, greatly magnified, at figure 131 : it is distinguished by a double row of little nodules, separated by a longitudinal canal, and the body is surrounded with cilia, as seen in the drawings : it propagates by a transverse division.

221. *LEUCOPHRYS signata*.—This is an oblong animalcule, slightly curved : near the middle may be discerned a tubular canal, in the form of the letter S, having one end terminating in a spiral. Common in November and December, in sea-water.

222. *LEUCOPHRYS trigona*. *The three-cornered Leucophrys*.—This is a thick animalcule, of a yellow tint ; the edge ciliated, and the interior filled with digestive sacs of various diameters. Scarce. Found in the water of marshes.

223. *LEUCOPHRYS fluida*.—This is a singular animalcule, which Ehrenberg thus marks (?), to denote that he is not certain where to place it. Sometimes it resembles the last species, at others the *Kolpoda cucullus*. It propagates both by longitudinal and transverse division, and emits occasionally a mass of molecules, probably spawn ; it is

surrounded with cilia, and is about 1-400th of an inch in length. Found in the common muscle.

224. *LEUCOPHRYS fluxa*. This animalcule is found along with the last, and does not differ greatly from it. It is generally of a contorted bean-shape, fringed with cilia.

225. *LEUCOPHRYS armilla*. *The bracelet Leucophrys*.—This curious annular animalcule is also found with the two preceding, but is more scarce: its form is shewn at figure 139, with a portion of the inner edge ciliated. Sometimes the circumference only appears ciliated.

226. *LEUCOPHRYS cornuta*. *The horned Leucophrys*.—This animalcule is shewn, magnified, at figure 138: it is in the form of an inverted cone, the mouth aperture being at the base, which is ciliated, and furnished with a horn at each corner: as these are not always visible, they are probably clusters of cilia; but this future observation must determine. The posterior extremity sometimes consists of a single point; at others, it is separated into two or three points: occasionally, the sides may be observed ciliated. From the globular sacs in the interior, its polygastric structure may be inferred. Found in stagnant water.

227. *LEUCOPHRYS heteroclita*. *The variable Leucophrys*.—This animalcule is visible to unassisted vision, being nearly 1-40th of an inch in length. In swimming it is ellipsoidal, and under a deep power appears covered with cilia, as shewn in the sketch, figure 136. When stationary, it alters its form, and thrusts out two

plumed processes, similar to the rotatory organs of the wheel animalcule. (See figure 137.) Found in water-butts and cisterns.

228. *LEUCOPHRYS pyriformis*. (New species, E.)—*The pear shaped Leucophrys*.—This creature resembles the *Kolpoda pirum* (163), but may be distinguished from it (when a little indigo is added to the water) by the presence of longitudinal fringes of hair, as shewn at figure 163. Near the mouth, which is situated at the side, the cilia are longest: these occasion currents in the water, as indicated by the arrows. They propagate by division. Figure 162 is a young specimen, in which, as in figure 163, the dark spots represent the gastric sacs filled with opaque food. Length, 1-280th of an inch.

229. *LEUCOPHRYS patula*, E. (*Trichoda patula*, M.)—*The wide-mouth Leucophrys* is included in the genus *Trichoda*, by Muller; but as Ehrenberg demonstrates that it is entirely covered with cilia, I have placed it with the *Leucophrys*. It is a large animalcule, and therefore a good subject for examination as to the form of its alimentary organs, which consist of a tubular membrane, the anterior extremity of which is dilated, and forms the mouth: it then proceeds through the body, taking a serpentine course, and terminates at the lower extremity, where it is enlarged. During its progress it sends out short tubular branches in all directions; these are terminated by small spherical sacs or stomachs, like those of the *Enchelis* (70, fig. 41).

Figure 159 shews this animalcule magnified 380 times,

and exhibits the cilia, which cover the body ; the long setaceous hair surrounding the mouth ; the curved alimentary canal and polygastric stomachs, in different states of repletion. It propagates by a diagonal division, and the animalcule, when just separated, is shorter than afterwards, as shewn at figure 160. Found in various vegetable infusions, and measures 1-120th of an inch in length.

GENUS XIII.

TRICHODA.

DIAPHANOUS, PARTIALLY CILIATED ANIMALCULES.

THIS genus is very extensive, and contains several species of the *Rotatoria*, with a complete alimentary canal, as well as many of the polygastrica. Some of them are of sufficient size to be visible to unassisted vision.

(A.) *Polygastrica*. (a) *nuda*.

230. TRICHODA *grandinella* (*Trichodina grand. E.*)
The hoar-frost Trichoda.—This is a minute polygastric animalcule, with a single circle of cilia: it resembles the *Vorticella convallaria*, but has no foot-stalk or pedicle. The best method of observing the cilia is by employing an intense illumination, and reducing the quantity of light by diaphragms under the stage*, till the maximum of distinctness is obtained. I have always found that the addition of a little colouring matter, finely divided, lessens the difficulty of discovering them. Figure 135 is a magnified sketch of this species. Size, 1-1100th of an inch. Found in vegetable infusions.

231. TRICHODA *cometa*. *The comet Trichoda*.—This

* See "Microscopic Cabinet," page 128.

curious animalcule, which is shewn, magnified, at figure 134, is of a globular form, furnished at its anterior end with a number of long setaceous hairs, and at the opposite extremity are often attached by a thread one or two globular bodies, probably young. Found in clear river-water.

232. *TRICHODA granata*. *The granulated Trichoda* is probably only a variety of the last: the interior is opaque, and the circumference furnished with cilia. Found among duck-weed.

233. *TRICHODA trochus*.

234. *TRICHODA gyrinus*.—These two species are so much like the *Trichoda grandinella*, that it is unnecessary to give a separate description. The last is very small, and found in sea-water.

235. *TRICHODA sol* (*Actinophrys sol*, E.) *The sun Trichoda*.—This animalcule is globular, as shewn at fig. 156, and covered with radiated hairs: in its interior may be counted as many as twenty polygastric sacs. Its mouth is elongated into a proboscis, as shewn at fig. 158; this the creature can contract at pleasure, and when turned towards or from the observer, appears like an oval sac, as shewn by the dotted line and cross below figure 156. It propagates by division; one of which, about to separate into two, is shewn at figure 157.

This creature is an interesting object for the microscope: it preys upon other animalcules by suction, and has been found attached to the *Kerona pustulata*. Size, 1-900th of an inch.

236. *TRICHODA vulgaris*.—This animalcule forms a

new genera, called by Dr. Ehrenberg *ARCELLA*, which I have thought would best be described after the *Trichoda sol.* Dr. E. has observed three species, but has only figured the *Vulgaris*, whose crustaceous covering is in the shape of a cup, at the circumference of which radiate several strong spines, as shewn at figure 155 ; and at the edge-view, figure 154.

The shell is delicately fluted, and of a pale brown colour ; the body clear, like crystal. The spines, which are attached to the body of the animalcule, and not to the shell, can be contracted at pleasure. Sometimes it only thrusts out two of them ; but when all are expanded, seven are seen. The mouth aperture is on the flat side, as shewn by the cross. Its polygastric structure may be seen in the drawing. It varies considerably in size, some full-grown specimens measuring in diameter 1-240th, while others are only 1-1200th of an inch. Ehrenberg, in his description, states that he has, since his systematic arrangement was printed, discovered an allied genus, which he calls the proper *Diffugia* : it is distinguished by a pointed projection from the surface of the shell, and is larger than the *Arcella* : he names it *DIFFLUGIA acuminata*, or the *pointed changeable animalcule* : like the other, it will not feed on colouring particles.

237. *TRICHODA solaris*.—This animalcule is rather less than the sun *Trichoda* ; spherical, with seldom more than seventeen wavy hairs on the circumference. In addition to the polygastric sacs seen within it, there may

be distinguished a bright serpentine line. Found in sea-water.

238. *TRICHODA bomba*.—This is a globular animalcule, with cilia around the mouth, like the *T. grandinella*, figure 135 ; but the body varies in form ; sometimes it is elongated like a pear, with the end bent ; at others, it increases in width, and appears uniform, while occasionally it is observed spirally convoluted : it swims with great celerity, and is with difficulty followed under the microscope. Found among healthy duck-weed.

239. *TRICHODA orbis*.—This is larger than the last, more transparent, and of a globular form, with one side indented, and furnished with a cluster of long cilia. Found in clear river-water.

240. *TRICHODA urnula*. *The pitcher-shaped Trichoda*.—This is a large membraneous animalcule : the body rather long ; the posterior enlarged ; the anterior truncated ; and its edge surrounded with short cilia. Its motion is slow.

241. *TRICHODA diota*, shewn at figure 140, is named from its supposed resemblance to a drinking vessel with two ears. It is probable that the entire edge is furnished with cilia, like the *Vorticella convallaria*, but from the minuteness, transparency, and velocity, they have not been discerned.

242. *TRICHODA horrida*.—Egg-shaped, with the mouth placed at the larger end ; the body is covered with long cilia, deflected towards the posterior. Found in the muscle.

243. *TRICHODA urinarium*, flask-shaped, with the mouth ciliated. Found in stagnant water.

244. *TRICHODA semiluna*.—This animalcule resembles the moon at the first quarter; the ends are truncated, and the upper one furnished with cilia.

245. *TRICHODA trigona*. *The three-sided Trichoda*.—The apex of this triangular-shaped animalcule is furnished with cilia, and the mouth is a longitudinal aperture near them, on the inferior side; the lower corners are obtusely blunted.

246. *TRICHODA tineæ*.—A club-shaped animalcule, with the smaller or anterior extremity ciliated.

247. *TRICHODA nigra*. *The black Trichoda* is of an elliptical form, with the anterior ciliated: the inside sometimes appears violently agitated when the creature becomes very opaque. Found in sea-water.

248. *TRICHODA pubes*.—A large bag-like animalcule, with several digestive sacs: when the water has nearly evaporated, it stretches out its head, and exhibits a row of cilia and several folds along the body. Found in December.

249. *TRICHODA floccus*.—This animalcule, found in stagnant water, is shewn at figure 141. The anterior is pointed, and the posterior furnished with two or three clusters of hair: it is capable of contracting its body.

250. *TRICHODA sinuata*.—This is a long trichoda, tapering towards the anterior extremity; the body is in the form of a crescent, with the concave side ciliated.

251. *TRICHODA præceps*. *The quick Trichoda*.—This animalcule is represented at figure 142; it is capable of extending the neck. I found it in an infusion of the

Tradiscantia virginia, but omitted to measure it. The magnifying power employed was about 400: it has a cluster of strong cilia under the neck, like a beard.

252. *TRICHODA proteus*. *The changeable Trichoda*.

253. ——— *versatilis*.—These two species of Muller are probably only varieties of the same; the latter was found in sea-water, the former in fresh river-water. In form it resembles the swan *Vibrio*, and like it the neck is capable of great extension and contraction; sometimes exceeding in length that of the body; at others so contracted as to be invisible, and the part of the body from which it protrudes only occasionally discernible by a cluster of cilia around the head: these produce a strong current of water towards it: the posterior extremity is pointed, and the creature is about 1-60th of an inch in length when the neck is contracted. It was discovered by Baker, in the slimy matter which covered the surface and adhered to the sides of vessels containing water snails, small fish, and larvæ. Baker, when he discerned it, was highly delighted at its changes and movements. It is certainly an admirable object for the microscope, and no doubt, with the assistance of coloured particles, in a good instrument, much of its internal structure might be ascertained.

254. *TRICHODA gibba*. *The hunch-back Trichoda*.—This animalcule is convex on the upper side and plane beneath: it is like the *Trichoda fasciola*, figure 167.

255. *TRICHODA foeta*.—This is a spindle-shaped animalcule, with the anterior extremity longest, and furnished with a few cilia: it can contract itself into a

globular mass. When it casts its spawn, the posterior is dissipated like the *Kolpoda cucullus*, and its form entirely changed.

256. *TRICHODA patens* (*Urostyla grandis*, E.) *The gaping Trichoda*.—This is a long cylindrical animalcule, with the mouth-aperture, which is large, and surrounded by long cilia, placed longitudinally near the upper end. (See Book III.)

TRICHODA patula. (229, page 119.)

257. *TRICHODA foveata*. *The oblong, three-horned Trichoda*, has the anterior part ciliated: it probably belongs to the section Oxytrichina; Book III.

258. *TRICHODA striata*. *The striped Trichoda* is very diaphanous, and resembles the *Kolpoda*, figure 84. The body is long, the upper extremities smallest, and ciliated on the concave side to the middle, when it is abruptly enlarged. Found in river-water, in December.

259. *TRICHODA uvula*.—This is a minute animalcule, rather flat, nearly of an equal size from one end to the other, which is six times its breadth: anterior ciliated. Found in an infusion of hay, &c.

260. *TRICHODA aurantia*. *The orange-coloured Trichoda* is found among *lemna*; it resembles the *Kolpoda cucullus*; figure 89.

261. *TRICHODA prisma*. This is a small pellucid boat-shaped animalcule; the under side convex, and edged with a bright longitudinal line. Found in sea-water.

262. *TRICHODA ignita*.—This animalcule is shewn, magnified, at figure 143: a row of cilia and two setaceous

hooks are seen on one side, and a large aperture near the posterior extremity. It propagates either by a transverse or longitudinal division.

263. *TRICHODA forceps*.—This curious animalcule, shewn at figure 153, has the upper part of the body produced into two long ciliated lobes, one pointed, the other obtuse; these the creature can open or close at pleasure, like a pair of forceps, or cross them, as shewn in the drawing. Found among *lemna*.

264. *TRICHODA forfex*.—This is larger than the last, and, like it, furnished with forceps: one side is very short, and the other ciliated: two small protuberances are observed at the lower extremity. I am inclined to think it is some other species undergoing division.

265. *TRICHODA index*.—This animalcule was found in salt-water: figure 144 gives a magnified view of its form and the disposition of the cilia.

266. *TRICHODA S*.—Striated animalcule: the fore-part ciliated; the extremities curved in opposite directions, like the letter S.

267. *TRICHODA navicula*. *Three-sided animalcule*, like an isosceles triangle: the mouth is situated at the base, and ciliated: the apex of the triangle is bent: it is convex on the under side, with a longitudinal line. Found in salt-water.

268. *TRICHODA succisa*. *Flattened oval animalcule*: the edges ciliated, except at the curved hollow near the posterior extremity. Found among *lemna*.

269. *TRICHODA sulcata* is shewn, magnified, at figure

145: it has two rows of cilia; the mouth is situated near the acute end: it is often seen with a number of dark spots; and when viewed sideways, only one row of cilia can be observed. Found in the common muscle.

270. *TRICHODA anas* (*Trachelius anas*, E.) *The duck Trichoda* is distinguished from the *Vibrio fasciola* (114), in being convex on the under side, while the latter is flat. The organization of the two species strongly resembles each other: I have therefore placed the drawings in juxtaposition: figures 166, 167, 168, and 170, representing the *fasciola*, and figures 164, 165, and 169, the duck *Trichoda*. Their bodies are covered with rows of cilia, and their mouths situated on the under side of the neck, as shewn by the cross. When fed with coloured substances, some of the larger sacs remain pellucid, as filled with water. Length, 1-120th of an inch.

271. *TRICHODA barbata* is probably the young of the *E. pupa*, figure 37: the anterior extremity is smallest, and ciliated on one side.

272. *TRICHODA farcimen* is shewn, magnified, at figures 146 and 147.

273. *TRICHODA crinita* is like figure 168.

274. *TRICHODA angulus*.—This animalcule is long, and bent near the middle, forming an angle. I am disposed to think it is about to divide, and therefore mistaken by Muller for a distinct species: the anterior is ciliated.

275. *TRICHODA lenter*.—Egg-shaped animalcule, with one end ciliated, and the body slightly curved. Found in an infusion of grass.

276. *TRICHODA vermicularis*.—This creature is shewn

at figures 148 and 149: the neck is capable of elongation, and the head is furnished with cilia.

277. *TRICHODA paxillus* is a small cylindrical animalcule, with the anterior ciliated.

278. *TRICHODA melitea*.—This singular animalcule is shewn at figure 152; it can contract itself at pleasure: a peristaltic motion is sometimes observed. Scarce.

279. *TRICHODA ambigua* is shewn, magnified, at figure 161. Sometimes it appears like a bent cylinder, without cilia, and protrudes a short proboscis from the anterior. Found with the two preceding in sea-water.

280. *TRICHODA fimbriata*.—This is like the *Kerona haustum*. It is egg-shaped, with the lower end pointed, resembling a top. The larger extremity is furnished with a row of long fimbrillæ, and one side is serrated.

281. *TRICHODA camelus*.—This is similar to the last, except that the end is rounded, the body not symmetrical, and the side without serratures.

282. *TRICHODA augur*.—This animalcule is shewn at figure 151: it has three hooks or claws, below which is a fringe of long hair.

283. *TRICHODA pupa* resembles the pupa of the common gnat in miniature: the head is globular, and ciliated on the upper margin; the body taper and bent; at the lower part of the head is a large pellucid corpuscle.

284. *TRICHODA clavus*.—This is a small animalcule, with the head ciliated, as shewn at fig. 150.

285. *TRICHODA gallina* is represented at figure 174. Found in river-water.

286. *TRICHODA musculus*.—This animalcule is nearly

cylindrical when extended : in contracting, the body is enlarged more than the head ; the anterior is ciliated ; the tail emanates from the lower side.

287. *TRICHODA delphis*.—This species appears closely allied to the *T. fimbriata* and *T. camelus* (279 and 280). The posterior is produced in the present species, and bent upwards. The head, which is circular, is furnished with long radial cilia.

288. *TRICHODA delphinus*.—Egg-shaped animalcule, with the posterior produced, bent upwards, and enlarged at the extremity : the fore part is ciliated.

289. This animalcule resembles figure 174, but has no cilia at the posterior extremity.

290. *TRICHODA cuniculus*.—Oblong ; the anterior ciliated and obtuse ; the posterior pointed. Found in clear water.

291. *TRICHODA felis*.—A long curved animalcule : the anterior smaller than the body, which gradually diminishes, and forms the tail : the head is ciliated, and the body furnished to its extremity with a single row.

292. *TRICHODA piscis* (*Oxytricha piscis*, E.).—*The fish Trichoda* has a blunt head, fringed with bristles ; a body gradually diminishing in size, and terminated by a slender tail. (See Book III.)

293. *TRICHODA fixa*.—This is a globular animalcule, with a long slender proboscis, and the body is covered with short radial hair. It is often attached to the *Leucophrys signata*.

294. *TRICHODA transfuga*.—In form resembling the

Bursaria, figure 99: the anterior is ciliated, and the posterior furnished with bristles. Propagates by transverse division.

295. *TRICHODA ciliata*.—This is a three-sided animalcule, with the angles rounded: it has a row of long cilia, like a comb, on one side, and the other fringed with short bristles. Found in the common muscle.

296. *TRICHODA bulla*.—This animalcule only differs from the *Bursaria duplella* in having a cluster of cilia at each extremity. Found among confervæ.

297. *TRICHODA pellionella*.—This animalcule is nearly cylindrical, with the extremities rounded; the anterior delicately ciliated, and the posterior furnished with bristles.

298. *TRICHODA cyclidium*.—This is more globular than the preceding one, and its anterior is divided; in other respects it resembles it.

299. *TRICHODA cursor*.—This animalcule resembles the *T. augur*, figure 151; but the anterior is symmetrical and ciliated; and in addition to the cluster of long bristles on one side, there are a few on the other, near the posterior. A large circular spot is observed at the head.

300. *TRICHODA pulex* resembles the *T. pellionella* and *cyclidium*, with an indentation on the under side near the head.

301. *TRICHODA erosa*. The *escutcheon animalcule* is shewn at figures 180 and 181. In some specimens the anterior is concave.

302. *TRICHODA rostrata*.—Body nearly circular: the

anterior part is produced and curved, near to which, within the margin, are disposed four strong hooks ; below these, on the same side, is disposed a row of long cilia.

303. *TRICHODA lagena*. *The bottle-shaped Trichoda*.—The form of this animalcule is similar to a Florence oil flask : the neck is small and transparent ; the body terminated with a row of bristles.

(b) *Loricated*.

404. *TRICHODA inquilina* (*Vaginicola*, L.).—This curious animalcule, which is shewn at figure 175, is inclosed in a diaphanous tube ; sometimes two of them are seen in the same shell, as shewn in the sketch ; this is probably an animalcule divided : when a single individual occupies the shell, it is generally longer, and the tail reaches to the bottom of it.

305. *TRICHODA ingenita*.—This animalcule is inclosed in a delicate shell, slightly contracted near the aperture, as shewn at figure 178. The inhabitant is soft-bodied, and can either contract itself, so as to remain entirely within the shell, or stretch itself out, and protrude beyond it : the upper extremity is furnished with cilia, like the *Vorticella convallaria*. It propagates by a longitudinal division. Found among confervæ.

306. *TRICHODA innata*.—This animalcule, which is shewn at figure 179, is distinguished from the preceding by the form of the shell, the tail being produced beyond it. It is an entertaining object for the microscope.

307. *TRICHODA lynceus*. (*Aspidisca*, E.)—This animalcule is nearly circular, flat, and covered with a delicate shell; it resembles in miniature the round *Lynceus*, drawn and described in the "Microscopic Cabinet," having, like it, a sharp pointed rostrum or beak, with a cluster of delicate hairs beneath it; the margin of the opposite end is furnished with bristles. Size, 1-900th of an inch.

308. *TRICHODA charon* (*Euploea*, E.)—*The charon boat-shaped Trichoda* has a strong resemblance in its external characters to the animals of the class Entomostracea, and, like the genera *Amymone* and *Nauphius**, its back is protected by a shell. This crustaceous shield is very thin, and so transparent that when the water is clear it is scarcely perceptible. Figures 182 to 186 represent various views of it. The form of the shell varies in different specimens: the most general shape I have observed is shewn at figure 182, one side overlapping more than the other. It usually swims on its back, in which position the bristles on each side of the body, and the cluster towards each extremity, can be seen: the side bristles mostly appear vibrating, in this situation of the animal; even when it is stationary they produce a current in the water, probably for the purpose of bringing a fresh portion for respiration. The mouth is situated at the side, near the row of cilia; it is a longitudinal aperture, commencing near the apex of the

* See "Microscopic Cabinet," page 84.

shell, and terminating a little below the middle : in the centre of this, Dr. E. has observed the small aperture of the throat. They have sometimes appeared to me to receive the food at the upper end, which in some individuals is indented. I have never succeeded in feeding it with indigo, but finely divided carmine it swallows freely, and the digestive sacs may be observed to fill in succession. It also devours the *Monas punctum*, which is attached by a filament to decomposed vegetables ; this it accomplishes by a sudden spring at the Monad, instantly retreating as soon as it is caught. When it swims it is very nimble, and difficult to examine : it sometimes creeps, employing the lateral and end bristles for feet, as shewn at figure 186. It propagates both by longitudinal and transverse division : the latter is shewn at figure 185 : it would also appear to be produced from spawn ; (see the young one, figure 183.) Found in various vegetable infusions. Size, 1-280th of an inch. Magnifying power from 300 to 500.

309. *TRICHODA cunex*.—This animalcule is covered with a crustaceous shield, and resembles the last, excepting that no longitudinal furrows are ever observed on its back ; it is furnished with a cluster of strong bristles at each extremity ; these it employs as feet when it walks.

310. *TRICHODA cicada*.—Oval, with a dark margin, and the anterior furnished with fine cilia in addition to the bristles, as in the preceding species, from which it does not differ essentially.

311. *TRICHODA comosa* (*Trichodina*, E.). *The hairy Trichoda*.—Size, 1-500th of an inch.

312. *TRICHODA paramaecium*, E. — New species ; 1-1000th of an inch.

(B.) *Rotatoria*.

313. *TRICHODA larus* (*Chaetonotus larus*, E.)—This animalcule is shewn, magnified, at figure 176. The specimen from which I took the sketch was 1-100th of an inch in length. It is quick in its movements, gliding through the water, and turning every instant, as if endeavouring to conceal itself. Rotatory cilia have been discovered, and a simple alimentary canal, in which latter respect it is allied to the *Cercaria podura* (182), and the genus *Enteroplea* (Book III.) ; all of whom have a long œsophagus, and are destitute of masticating organs. They form the division *Trachelogastrica* of Dr. E.

314. *TRICHODA lunaris* (*Rattulus lunaris*, B.)—This is a long cylindrical animalcule : the head convex, and taper towards the posterior, which is furnished with a single tail : it is capable of inflecting the body ; hence the name moon-shaped. (See Book III.)

315. *TRICHODA bilunis*. This animalcule differs from the preceding in having two setaceous tails ; it is flatter also, and when bent there is a projection on the concave side, forming a double lunate figure.

316. *TRICHODA rattus* (*Monocerca rattus*, E.)—This animalcule, a sketch of which is given at figure 172,

usually has the tail deflected, as shewn in the drawing.
(See Book III.)

317. *TRICHODA tigris*.—*The striped Trichoda* resembles the preceding, but the head is convex, and there is a slight contraction or neck: the body is terminated by two long bent setaceous tails.

318. *TRICHODA pocillum* (*Dinocharis*, E.)—*The little cup-shaped Trichoda* is shewn, magnified, at figure 171: it is a highly-organized creature, and the muscular structure of the body can be clearly observed.

319. *TRICHODA cornuta* (*Monostyla cornuta*, (?) E.)—*The horned Trichoda* is shewn at figure 173. The head of this animalcule can be withdrawn at pleasure, when the concave end of the shell can be more distinctly seen. Length, 1-140th of an inch.

320. *TRICHODA longicauda* (*Scaridium*, E.)—*3 long-tailed Trichoda* is a very interesting animalcule, and under a good instrument a considerable portion of its highly-organized interior may be perceived. I have given a sketch of it at fig. 177. The head and body can be contracted at the pleasure of the animalcule.

GENUS XIV.

K E R O N A.

ANIMALCULES, furnished with hooks (*uncini*), bristles (*setæ*), or horn-like processes; they form part of the section *Oxytrichina*, Book III.

321. *KERONA pustulata*. *The bladder-claw animalcule*.—This species is large, and is very generally to be found in vegetable infusions. They are difficult to examine, from their irritability under the microscope, rapidly changing their course from one direction to another, thereby fatiguing the eye, and confusing the attention of the observer. Figure 198 represents a full-grown specimen lying on its back, and producing a current in the water. The mouth-aperture is a longitudinal opening, furnished with cilia, and five hooks or claws on the left side; the absence of which in the genus *Oxytricha* distinguishes it from this. Figure 197 is a side view, shewing the manner in which it creeps. Independently of its usual mode of propagation by transverse division, there are two other methods by which the species is increased: one, by a germ issuing from the side of the parent, which, when sufficiently matured, is severed from it; they are distinguished from those animalcules produced by division by

their minuteness: one of them is shewn at figure 191. Another mode of propagation is from spawn; and, as in the case of the *Kolpoda cucullus*, a dissolution of part of the animalcule is effected at the same time it casts the spawn. The form of the creature varies greatly, and Dr. E. states, that unless he had actually observed these changes, he might have mistaken it at different times for so many distinct species. If they are fed with colouring matter, their polygastric sacs may be readily discerned, as also a duct near the extremity. Length, 1-240th of an inch.

324. *KERONA rastellum*.—This animalcule is nearly circular, with a small projection at one edge: the upper surface is covered with three rows of hooks. Found in river-water.

323. *KERONA lyncaster*.—This is nearly of the same form as the preceding species, but has a projection at each extremity: the anterior is furnished with bristles, the posterior inflected backwards, and the under surface covered with stout long hairs. Found among confervæ.

324. *KERONA patella* is shewn at figures 188 and 189. The body is covered with a shell, and is furnished with bristles, as shewn in the sketch. The front ones are strong, like hooks: these it employs, together with the posterior, in walking, and when it swims it is usually on its back.

325. *KERONA vannus*.—This animalcule resembles the next species, figure 187, but is fringed on one side, like

the *T. charon*, and has a cluster of long bristles at each extremity.

326. *KERONA calvitium* has three hooks at the anterior, and two long spines at the posterior; it is covered with a shell, and sometimes appears surrounded with cilia. Figure 187 is a magnified view of it swimming.

327. *KERONA mytilus* (*Stylonychia*, E.)—The form of the body is oval: it is destitute of a shell, though the extremities appear as if protected by a thin plate. The anterior is furnished with two horns, which, when in motion, produce a current towards the mouth. In some specimens the margin is surrounded with cilia; in others, they are only observed at the extremities: near the posterior are two long spines.

328. *KERONA lepus* (? *Oxytricha lepus*, Bory).—This animalcule is of an ellipsoidal form: the fore part, which is furnished with cilia, is smaller than the posterior, and is beset with bristles. Size, 1-500th of an inch.

329. *KERONA histrio* (*Stylonychia*, E.)—This animalcule is shewn, magnified, at figure 199: the anterior is furnished with styles, and five hooks may be seen on the under side, as also a cluster of long cilia near the posterior extremity.

330. *KERONA cypris*.—This species is pear-shaped, not symmetrical, and the mouth at the longest end is furnished with cilia and a few hooks, which, by their vibration, occasion a current in the water.

331. *KERONA haustum* is nearly circular, with the

edge surrounded by long cilia (radiating like a fan): the posterior is rather pointed, and has from five to seven long bristles. Two horns may be observed near the middle. Found in sea-water.

332. *KERONA haustellum* resembles the preceding; but the marginal cilia are shorter, and it has no terminal bristles: the two horns are nearer the front edge.

333. *KERONA pullaster* (*Oxytricha*, E.)—This animalcule is shewn at figure.190: the fore part, in addition to the cilia, is stated to have three setæ. The cilia, at the opposite extremity, are often separated; at other times they are collected in a cluster, as shewn in the sketch.

334. *KERONA silurus*.—In form this species resembles the *K. histrio*, but the head is sometimes more pointed, and the bristles at the lower end project beyond the body; among these, filaments of confervæ often get entangled: the back is covered with rows of setaceous hooks. They increase by transverse division.

GENUS XV.

HIMANTOPUS.

PELLUCID ANIMALCULES, WITH A CLUSTER OR TUFT
OF HAIR.

335. *HIMANTOPUS acarus*.—The mite animalcule is in the form of a pointed pear with the fore part diaphanous, and capable of elongation, and fringes of cilia may be discerned on its inferior side: it has four long setaceous hairs near the posterior; these it employs as feet, and runs very nimbly. Found among *lemna*, but scarce.

336. *HIMANTOPUS larva*.—This is a very lively creature, swimming and turning in the water in a graceful and diverting manner, inflecting itself, as shewn at figure 195: the body gradually decreases towards the posterior, and at intervals several hairs appear disposed along it. The margin is fringed, as shewn in the figure.

337. *HIMANTOPUS ludio*. This animalcule, like the preceding, is remarkable for the agility of its movements; it resembles it also in form, although it is more blunt, and the tail appears forked: the upper margin is fringed, and it has two clusters of long vibrating hairs on the in-

ferior side ; the first situated near the head, and the other near the middle of the body.

338. *HIMANTOPUS sannio*.—This animalcule is nearly as broad as it is long : the head is ciliated, and has two long vibrating cilia ; the posterior is acute, and furnished with a small cluster of short hairs ; polygastric sacs may be discerned within it. Found among *lemna*.

339. *HIMANTOPUS volutator*.—*The revolving Himantopus* is a small, bent animalcule, with the upper margin fringed, and the inferior one furnished with four hook-like setæ.

340. *HIMANTOPUS charon*.—*The boat-shaped Himantopus* resembles the *Kerona patella*, figure 323 ; but the terminal cilia are long and wavy, not stiff : the body is long in proportion to its breadth, and there are longitudinal markings on each side of its pellucid envelope. Scarce. Found in sea-water.

341. *HIMANTOPUS corona*.—This animalcule is shewn at figure 196. It is very thin, and the cilia, bristles, and vibrating hairs, are disposed in the manner shewn in the drawing.

GENUS XVI.

VORTICELLA.

THIS is an extensive genus. Müller enumerates seventy-five species, to which Bruguiere has added four others ; but I am inclined to think many of these are only different stages of the creature's development. They vary much in their organization ; hence I have formed them into two divisions. They are naked, contractile, and possess cilia circularly disposed near the mouth, producing a vortex in the water : in many of them they appear to rotate like a wheel ; to account for which, various hypotheses have been invented. According to Dr. E. this is occasioned by their peculiar disposition, and not from any difference of structure ; for as with the vibrating cilia, the base of each is a bulb (similar to the spines of the *Echina*), which by means of muscular fibres it can move in any direction, like a ball and socket joint. Thus each cilium in its revolution describes a cone, the apex of which is the bulb. Now, if the cilia are arranged in a circle, and viewed laterally while in motion, the whole wheel will appear to revolve as each cilium passes ; first, a little nearer the eye on this side of the cone, and then further off on the other side.

FIRST DIVISION.—POLYGASTRICA.

342. *VORTICELLA viridis*.—*The green Vorticella* is found in clear water, and on close inspection can be perceived by unassisted vision : it is long and nearly cylindrical, but rather larger at the anterior, which is furnished with cilia ; these produce a vortex in the water : the end is spherical ; it does not contract or alter its shape, and in swimming it often rotates on its longer axis.

343. *VORTICELLA sphæroidea*.—*The globular Vorticella* is, like the preceding one, of a dark opaque green colour ; it is somewhat egg-shaped, and the anterior has a circle of rotatory cilia.

344. *VORTICELLA cincta* (*Peridinium cincta*, E.)—*The girdle Vorticella*, sketched at figs. 237 and 238, is of an opaque green colour, nearly globular, and furnished with transverse bands of cilia : when about to divide, it elongates in one direction, and the middle becomes transparent.

345. *VORTICELLA lunifera*. *The moon-shaped Vorticella* in form resembles the moon at her first quarter : the mouth, situated near the middle of the convex edge, is furnished with cilia ; the two horns are rounded, and form the sides of the animalcule ; at the centre of the concave side (which is the posterior part of the animalcule) is a small projection. Found in sea-water.

346. *VORTICELLA bursata*.—*The purse-shaped Vorticella*, shewn, magnified, at figure 207, has a short pelucid neck, the edge of which is surrounded with cilia : this transparent envelope terminates the anterior extremity of the body in a conical point, as seen in the draw-

ing : it occasionally appears indented, but its definition is difficult, from the motion of the intervening cilia, which sometimes move erect, and at others are curved outwards.

347. *VORTICELLA utriculata*.—The bottle-shaped *Vorticella*, shewn at figure 208, appears so closely allied to the preceding one, that I have introduced it here. It is of a green colour, and no interior projection or nipple is observable ; the body and neck are capable of considerable extension and contraction, and the rotatory cilia are either erected or deflected at the pleasure of the animalcule. Found in salt-water.

348. *VORTICELLA sputarium*.—This animalcule assumes appearances so different, according to the position in which it is viewed, that it is difficult to present a clear idea of it : in swimming, if viewed sideways, it appears cylindrical, the anterior being dilated, and the posterior contracted and convex : a series of long radial cilia may be observed, and the body of the animalcule appears a globular opaque mass. Found at the end of summer among *lemna*.

349. *VORTICELLA polymorpha*, *V. multiformis*, and *V. stentoria*, I am inclined to believe, are only varieties of the same species. By their great powers of extension and contraction, and also by their being sometimes attached to the surface of vegetable or other substances, and at others swimming freely, they assume such different characters, that unless attentively watched they may be easily mistaken for different animalcules. The *Leucophrys cornuta* (226) is probably allied to them, as

imperfect observation, with shallow magnifiers, gives the cilia, in certain positions, the appearance of horns.

The most usual form in which these creatures are observed, is shewn at figure 209; the lower end of which represents a portion of a leaf of duck-weed, to which the animalcule is attached: around the upper part are arranged a series of cilia, which, when put in motion, produce a rapid current in the water towards the mouth of the *Vorticella*. In this drawing, which I made from actual observation, the animalcule was slightly contracted, and very transparent towards the upper part: the cilia were very distinct, and the whole measured the 1-100th of an inch in length.

These creatures often detach themselves, and swim about freely in the water; they are then generally observed in the form shewn at figure 224, and are called *trumpet Animalcules*, or *funnel-shaped Polype*. The body is sometimes quite straight, and not curved as in the drawing; in the former position, they glide along in the water, occasionally revolving about a line parallel to one of their sides, which gives them an oscillating appearance: from this peculiarity, which has not hitherto been noticed, I presume the mouth aperture is not in the centre of the circle of cilia, but near the margin, as in the *Vorticella convallaria*: while swimming, the cilia are generally invisible, and the animalcule is often contracted and altered in form; it likewise swims occasionally with the tail foremost, the axis of rotation being then the axis of the animal.

These creatures are of various tints, white, blue, or green : the whirl of cilia is sometimes indented or formed in a spiral line ; in others, interrupted probably at the mouth aperture. Some specimens appear to possess a row of cilia along one edge of their bodies, the utility of which future observations may inform us. They vary greatly in size (from 1-20th to 1-100th long), which arises either from the quantity of food supplied, or from the state of their growth, as they propagate by division into unequal parts.

Their increase by transverse division has been recorded by Mr. Trembly, who states that it is first indicated by an oblique stripe where the lips or head of the new animalcule is to be produced ; the commencement of this is observed a little below the middle of the body, whence it proceeds about half round the parent : these lips are at first discerned by a slow motion ; they then insensibly approach each other, and close, when a protuberance is formed on the side of the body ; this afterwards becomes the head of the new animalcule, and the two may be plainly distinguished, the superior one being connected with the inferior by its lower extremity, which, by the motion of the cilia, soon becomes detached, and the parent swims away. Sometimes they propagate by longitudinal division, commencing at the head, one polype appearing with two distinct heads, as observed in the *polymorpha*.

350. *VORTICELLA nigra* is very similar in structure to the preceding, but the body is shorter and more pointed.

It is found near the surface of the water, among confervæ, and is about 1-50th of an inch in length and breadth. The head has a circle of cilia, the sides of which, by presenting to the view a greater number in the same space than the middle, have been mistaken for horns.

351. *VORTICELLA albina*.—This animalcule resembles a small *stentoria*, the end terminating in a point.

352. *VORTICELLA cucullus* is about 1-20th of an inch long, of a dull red colour, conical, with the circle of cilia apparently within its lip. Found in sea-water.

353. *VORTICELLA ocreata*—*V. valga*.—These animalcules, described by Müller as distinct species, appear to belong to the *polymorpha*, undergoing division.

354. *VORTICELLA convallaria*—*V. bellis*—*V. semila*. The bell-shaped *Vorticella* or *Polype* is an entertaining and well-known animalcule ; it is usually found attached to any extraneous body, as the leaves of duck-weed, small aquatic shells, clusters of ova, and the larvæ of insects ; an example of the latter is shewn in the Microscopic Illustrations, figure 30, where it may be considered as a *parasite*, or rather an *epiphytes*. As they are, when fully developed, attached mostly to some stationary object, they afford many facilities to the Microscopist for his observation ; they form a good object also for ascertaining the defining power of his instrument, and his expertness in its management, as much of the effect will depend on the manner in which he directs the illumination. If this be not attended to, and the instrument have not sufficient power and penetration, it will only exhibit two cilia

instead of circular rows ; indeed, this animalcule is described and drawn in this manner in all the old authors—an error which recent improvements in the microscope have demonstrated. This creature, when arrived at maturity, consists of a body in the form of a bell, the edge of which is furnished with a circular fringe of cilia : to the outside of the dome is attached one end of a long pedicle or stalk, and the other is fixed to some extraneous substance. They are gregarious, and their stems are connected in the manner shewn in figure 204, the bells being omitted.

When in search of prey, they stretch out the stem, and by means of a vibratory motion communicated to the cilia, they agitate the water and occasion a current towards them, as indicated by the arrows, figure 203 ; this brings along with it the small particles of matter on which they feed. Should any circumstance disturb the water, or a large animal approach them, they instantly retract, bending the stem into a number of coils, as shewn at figure 205 : this operation is performed so quickly that the eye cannot detect it ; in a few seconds, the creature may be observed slowly uncoiling the stem. In some of the larger species, as the *V. polypina*, a muscle has been observed within the stem which assists in this operation.* It has also been asserted that a circulating fluid has been observed in the stems. These curious animalcules are endowed with several methods of propagation, the observation of which has thrown much light upon this in-

* Transactions of the Society of Arts, Vol. 48.

teresting subject, and enlarged our views of the operations of nature in her minute productions: many creatures, which we formerly considered as belonging to distinct genera, are now ascertained to be the same in different conditions. For these researches we stand indebted to the labours of Dr. Ehrenberg, from whose drawings the figures are taken. One method of increase is probably from ova, but of this we have no direct evidence: Dr. E. considers that the spawn is ejected, as with the *Kolpoda* (159), and that it does not proceed from buds or germs from the roots; their first appearance is like several little specks rather darker than the surrounding mass, and possessing a tremulous motion; they are then not more than the 1-12000th of an inch in diameter, and are clustered about the roots or stems of the old ones, as shewn in figure 204: they do not change their situation, and are probably connected to the parent group by invisible filaments: they soon increase in size, when delicate stems may be perceived, as may also a current in the water towards the bell, indicating the presence of cilia. At this stage of their growth, as shewn at figure 205, they have been considered as a distinct species by Schrank, under the title of *V. monadica*, because at this period the stems do not contract spirally, as in the old ones. The opinion that the young are produced from spawn adhering to the stems, is favoured by the specimen drawn at figure 211, which is a *pyriform* variety, where a stem will be seen attached to the parent. From some of the specimens observed by Müller, it is evident that they are

also produced by buds, similar to the armed *polype** (see fig. 212.)

The next method of propagation is by a division of the parent. When this is to be effected longitudinally, the bell increases in breadth, and presents the form of figure 203: a separation then commences, and double circles of cilia are formed; the body of the animal then divides, and other cilia grow around the dome of the bell, assuming the appearance of figure 220: by constantly whirling, one or both^s of the bells separate from the stem, and swim about, in which condition they have been classed, as a distinct genus, under the name *Urceolaria*. Should it happen that both the bells are twisted off, the stem remains stationary, and does not contract afterwards, or produce a new bell. The most striking peculiarity which presents itself next is, that the end formerly attached to the stem swims foremost, and from the other end proceeds the new stem: before, however, this is effected, it changes its form, and sometimes buds out or separates. Figures 217 and 219 show them soon after separation; the latter is the genus *Eclissa*, of Schrank, and the former, with the small protuberance, *Rinella*, of Bory St. Vincent. If the creature retain its bell-shape, be not inverted, and exhibit the lower cilia, as figure 222, it forms the genus *Kerobalina* of the latter naturalist; and when all the cilia are invisible, as figure 221, then he calls it the genus *Craterina*. Again, it constitutes the

* Microscopic Cabinet, plate 7.

genus *Urceolaria*, when the anterior cilia are alone observed. Besides those already mentioned, there are many other changes in its form : sometimes it stretches itself out in length, and becomes cylindrical, so that it is readily mistaken for a species of the genus *Enchelis* (see fig. 223) : in this condition, one or both ends bend themselves while it is swimming past a hard body : it separates transversely in twain.

The next method of propagation is by the bud formation, which is not confined either to the animalcules with or without a stem : in the latter case, it is shewn at figure 218, and a young one, just separated, below it. It passes through a variety of shapes, moves briskly in the water, and forms the genus *Ophrydia* of Bory St. Vincent. Ehrenberg has divided this species into two varieties, founded on the shape of the bell : when they are nearly globular, he calls them *campanulata*, as figure 204, and *pyriformis*, when pointed, like figure 211 ; they differ in size from 1-200th to 1-900th of an inch.

355. *VORTICELLA citrina* resembles the preceding, but is much larger : like it, it possesses two concentric circles of cilia, and the mouth aperture is situated between them, and not in the centre. Figures 200 and 201 shew this creature magnified in the same proportion (380 times) ; in them may be perceived the two concentric circles of cilia, and the polygastric sacs, which are connected by a common tube (see fig. 202), terminating near the mouth. These facts are easily verified by means of coloured substances, owing to their superior size. Its shape varies

and passes through all the gradations of the preceding species. They are found in most vegetable infusions during the summer.

356. *VORTICELLA varia*—*V. truncatella*—*V. fritillina*.—These species of Müller, and some of the following, appear to differ so little from some of the forms of the *Convallaria* and *Citrina*, that I shall merely refer to those figures which they most closely resemble. This is like figure 221, with a circle of cilia around their upper edge.

357. *VORTICELLA papillaris*.—(See fig. 218.)

358. ———— *cirrata*.—(See fig. 202): the lower end is more convex, and furnished with cilia, while the

359. *VORTICELLA sacculus*, is without them.

360. ———— *nasuta*, (see fig. 217).—This animalcule is said to have bands of cilia around various parts of the body.

361. *VORTICELLA scyphina*—*V. hamata*—*V. crateriformis*.—Figure 204, without a stem.

362. *VORTICELLA stellina*, (*Trichodina*, E.)—This animalcule is described as surrounded with a halo, from which the cilia radiate; size, 1-288th of an inch.

363. *VORTICELLA discina*.—This singular creature, found in salt water, is shewn at figure 210.

364. *VORTICELLA limacina* only differs from the *Convallaria* in the dome of the bell being attached to some foreign substance, without the intervention of a stem, (see fig. 215.)

365. *VORTICELLA crategaria*.—These live in clusters, and are most commonly found in April attached to the

Monoculus quadricomis (see Microscopic Cabinet, Plate 9): the bell is of a globular form, several of them being clustered together with one common stem: this is sometimes wanting, in which case the cluster swims about, and resembles the *Volvox socialis*, but is larger.

366. *VORTICELLA canaliculata*.—I have not seen this animalcule: it is described by Adams as appearing to the naked eye like so many white specks adhering to the sides of glass vessels containing stagnant water; the anterior part, with the rotatory cilia, is smallest; there is an incision in the side, and it is notched at its posterior extremity.

367. *VORTICELLA versatilis*, (*Ophrydium*, E.)—This Vorticella is capable of elongating itself, or contracting into a bell-shaped body. Adams calls it a minute water hedgehog, from the cilia which surround it; it is of a beautiful green colour, paler and more transparent towards the edges, and its interior consists of a granulated mass of matter, or small round vesicles, (see Book III.) Dr. Wagner states, of this remarkable animalcule, that he never could induce it to feed on colouring matter. He says, also, that they are very numerous towards the end of October, congregating together, and forming large gelatinous balls an inch and a half in diameter: they are best adapted for microscopic observations, however, when about 1-120th of an inch*.

368. *VORTICELLA folliculata*.—A gelatinous, cylindrical

* Edinburgh Phil. Journal, vol. xiii. p. 251.

bag: when extended, the base is rather pointed. Found attached to the *Monoculus minutus*, (Microscopic Cabinet, page 88.)

369. *VORTICELLA socialis*.—These animalcules are found in societies, and appear to be the *V. crategaria*, with separate stems. The cluster, when expanded, is sometimes nearly half an inch in diameter.

370. *VORTICELLA pyriformis*.—This elegant species is larger than the *V. convallaria*, or common bell polype, with which it has been confounded. Under a good microscope, the stem will be observed enclosed in a sheath, like the genus *Vaginicola*, Book III.: it contracts in a zig-zag line (see figure 211), and is often surrounded by small protuberances like buds; these are the ova. Müller calls them knobs or scales. The bell of the animalcule is contractile, as shewn at the larger figure. To discover the existence of the stem within the sheath, it requires a magnifying power of 300-times: this stem has recently been examined by Mr. Varley, who considered it to be the muscular fibre. (Trans. Soc. Arts, v. 48.)

371. *VORTICELLA fasciculata*, (*Carchesium*, E.)—This belongs to the same genus as the preceding: the stem is sheathed, and the edge of the bell deflected: they are found in clusters, floating about on the surface of stagnant water; size, 1-400th of an inch.

372. *VORTICELLA nebulifera*, (*Carchesium*, E.)—The body is pear-shaped; the stem and the edges are deflected; but when it contracts the stem, the cilia are withdrawn, and the bell assumes an egg-shape.

373. *VORTICELLA digitalis* (*Epistylis*, E.)—This species, which is shewn at figure 229, is very scarce : it is remarkable, from the notched appearance of the bells when open. The stem is short and thick : it has but few branches, and does not contract spirally.

374. *VORTICELLA anastatica* (*Epistylis*, E.)—This gregarious animalcule differs mainly from the preceding in the shape of the edge of the bell, which is circular, like the *Convallaria* : they close and open the bells at pleasure, and all the branches arise from the top of a principal stem, which latter does not contract itself into a spiral form. The stems and branches are often surrounded with oviform germs, which grow rapidly under favourable circumstances, and on the second or third day are sufficiently matured to detach themselves, and swim about : a short pedicle or stem may then by careful observation be discerned to emanate from each of them : this is fixed to some proper substance in the vicinity of its food, when it gradually elongates, and the little bell changes its form from globular to egg-shaped, as it increases in size : it then by spontaneous scissure divides, and the two increase in size, and proceed to divide also, until a large cluster is formed. Mr. Trembley observed, in the course of twenty-four hours, one of these round buds or germs to form a cluster of more than 100 bells. All the individual bells of this society have a sympathy of action, although each appears to provide for its own nourishment ; thus if any one of the bells is touched by a fine point, the whole cluster immediately contracts.

375. *VORTICELLA pyrraria*.—The body of this *Vorticella*

is much longer than any of the preceding: it is shewn at figures 212 and 213: it is very common to observe these in pairs, each branch having two bells.

376. *VORTICELLA umbellaria*.—Clustering *Vorticellæ*; first noticed by Roesil, from whom the drawing of one of the globular bells, figure 225, is taken. Found in stagnant water.

377. *VORTICELLA ovifera* is found in clear water, and was first described by Spallanzani: the buds are large, and the main stem is sheathed, as shewn in figure 226; in other respects it is similar to the *V. anastatica*, of which it appears to me to be only a variety.

378. *VORTICELLA fraxinina*.—These are gregarious animalcules, and differ from the *V. digitalis* only in being destitute of a main stem.

379. *VORTICELLA vaginata*.—This polype is enclosed in a transparent shell-like tube, as shewn at figure 227: the bell is furnished with rotatory cilia: in other respects it has a strong resemblance to the *Trichoda*, figures 178 and 179.

380. *VORTICELLA patellina*.—This is a very broad polype, with a taper stem, as shewn at figure 216.

381. *VORTICELLA annularis*.—The ringed *Vorticella* is a large species, often found adhering to small fresh water shells. The bell is rather conical; the base of which, when closed, appears to have two or three rings or bands, which connect it with a stem that is generally twisted. Figure 246 shews an open and a closed bell, both magnified; and figure 247, their real size.

382. *VORTICELLA globularia*.—The ball *Vorticella* does

not appear to differ materially from the *V. umbellaria*, except that the present species is distinct, and not connected to a common stem. Figure 232 shews it magnified, both as contracted and elongated. They are commonly found on larvæ and entomostratia.

383. *VORTICELLA cyathina*.—This animalcule is shewn swimming freely at figure 231: the edge of the bell is ciliated, though not exhibited in the sketch: it can attach itself by the stem, which it contracts spirally.

384. *VORTICELLA putrina*.—This animalcule, shewn, magnified, at figure 240, is rather larger than the last, and does not contract its stem spirally. Found in seawater.

385. *VORTICELLA hians*.—*The gaping Vorticella* is very minute, and resembles the preceding: it is distinguished by a deep indentation at the mouth, probably the commencement of spontaneous scissure.

386. *VORTICELLA racemosa* is shewn at figs. 241 and 250. It consists of a cluster of bells with a common stem: when contracted, they resemble the *V. socialis*, and are only distinguished from them by their not swimming freely, but always attaching their long common stem to some fixed object: they expand and contract with amazing rapidity: by a scission of the parent into eight smaller ones, and each of these again into eight, a cluster is speedily formed from a single polype.

387. *VORTICELLA ampulla* (*Folliculina*, Lam.) *The pitcher-shaped Vorticella*, shewn at fig. 264, is enclosed in a curious shell-like case, which serves for a protection to

its delicate body : when disturbed, it can withdraw itself entirely within the case ; at other times it is protruded, and the cilia occasion a current towards it, whereby it procures its food. In some specimens the shell is elongated, and appears like the *Trichoda ingenita*, and occasionally two are observed in the same case, as at figure 236*, which indicates that they propagate by scission. It would be an interesting subject to ascertain how the shell is formed, and whether it can be reproduced, as I have sometimes discovered them without the animal. They are found among confervæ, and attached to the exuvia of insects.

388. *VORTICELLA opercularia*.—*The covered Vorticella* appears, from the description of Mr. Anderon, to be enclosed in a crustaceous sheath, with the upper part or lid moveable, as shewn in the drawing, figure 248. This lid or cover is surrounded with cilia, and it is connected to the interior of the bell by a long muscular cord : by means of the cilia it commands a wide range for procuring its food, but it retires on the slightest disturbance : in this state it does not appear that Mr. A. observed the cilia.

389. *VORTICELLA berberina* is shewn at figure 249, magnified. The bell is capable of withdrawing the stem from its sheath, and separating itself, as seen in the drawing. Little is accurately known of its habits, as it is very scarce.

390. *VORTICELLA ringens*.—*The chalice Vorticella* is

* Technical Rep. V. 6.

shewn open and closed, attached to the edge of a leaf of duck-weed, at figure 235.

391. *VORTICELLA inclinans*.—This is closely allied to the preceding, but the bell is generally inclined on its short stem.

392. *VORTICELLA lunaris* resembles the *V. convallaria*; but the bell is very broad, except when the stem contracts; it then becomes globular.

393. *VORTICELLA nutans*.—The stem of this *Vorticella* is very slender; it twists spirally, and is probably identical with the *V. convallaria*.

394. *VORTICELLA acinosa* has a bell-shaped body and rigid stem.

SECOND DIVISION.—ROTATORIA.

395. *VORTICELLA senta* (*Hydatina*, E.) *The ciliated, crystal Vorticella.*

We now arrive at the highest class of Infusoria, and in order to avoid repetition I propose to commence with the most perfectly developed species, instead of tracing them upwards as heretofore: by a minute perusal of this, and with the assistance of the drawings of the other species, the reader will obtain a general view of the whole without much trouble.

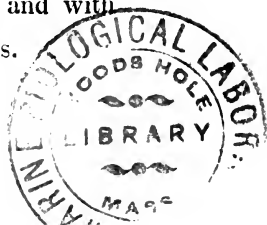
The superiority of the Achromatic Microscope, in the quantity of light which it transmits, has enabled the naturalist to develop more of the structure of these creatures than any of the numerous improve-

ments of the present day. Although this is one of the largest species of animalcules, yet all the authors who have written upon it have given only a moderately correct outline of its external form, and an indistinct account of its internal structure : such, indeed, was all that their imperfect instruments would enable them to do : it was reserved for the introduction of Achromatic Object Glasses, with their large angles of aperture, whereby so much additional light is transmitted, clearly to unfold all the minute parts to the view of the observer. These animalcules are very transparent and colourless, like water ; whence their name *Hydatina*, and the facility which they afford for observation.

This animalcule is visible to the naked eye. The largest specimens I have met with measured 1-30th of an inch in length, but they are more commonly found from 1-45th to 1-100th of an inch ; so that by attentive observation the smallest specimens can be discerned ; for a person with a good sight may perceive an object, held at the shortest distance for distinct vision, of one-third of that size. They are commonly found among confervæ and lemna. In vegetable infusions they are generally the last that make their appearance, being always preceded by the simpler polygastric kinds of the Infusoria, though the different species of the latter do not follow any regular order, even in different portions of the same infusion. They are broad in proportion to their length, as shewn in the engraving, figure 253, which represents a specimen, 1-96th of an inch in length, in its elongated con-

dition: figure 258 gives the same in its contracted form: both of which are taken from drawings by Dr. Ehrenberg.

This creature is enveloped in a double tunic, or coat, of a soft gelatinous substance. The fore extremity of the body is abruptly truncated, and furnished with seventeen muscular bodies of a globular form (only five of which are exhibited in the drawing). These are disposed in two concentric circles, their upper surfaces being furnished with several strong cilia, and their lower extremities connected by means of ligaments to muscular balls (*a*), so as to permit them to rotate, thereby enabling the cilia to produce a current in the ambient water towards the mouth, which is situated in the centre. At the entrance of the mouth and œsophagus is disposed on each side a series of indentations, or teeth, which are exhibited *in situ*, figure 259. "These are hard bodies, not edged in front, but bluntly pointed, which in their junction appear like the fingers of a hand, and are five in number on each side." In the common wheel animalcule (396), I have observed only three on each side, but they are larger, and very distinct, even while the creature is living. These teeth are fixed to the large muscular body (*b*), which possesses the power of alternately opening and closing, and the food passes through it into the alimentary canal (*c c*), in which are shewn several small animalcules (viz. *Navicula fulva* and *N. gracilis*, page 58), that have been swallowed: this canal terminates at (*d*), and with the glands (*e*) complete the digestive apparatus.



A muscular system being the proper agent of voluntary contraction in the animal kingdom, its existence might fairly be expected in the infusoria; creatures so remarkable for the rapidity and energy with which they propel and translate themselves from one situation to another. In respect to the former they can only be compared with fishes; in the latter, with insects. The mere contractibility of tissue can never surely afford a sufficient explanation of those active voluntary efforts by which they avoid every obstacle, where myriads of creatures are swimming in a single drop of water; by which also they convey nutriment towards their mouths, and perform the acts of deglutition.

From the extreme tenuity of the greater number of the animalcules already described, and of all the Polygastrica or the homogeneous Infusoria of Cuvier, no distinct muscular fibres have been detected, although from their vigorous contractions, as well as their presence in the class *Rotatoria*, we may infer their existence.

The superior size and diaphanous nature of this *Vorticella*, enable us under the microscope to discern several distinct bands of fibres of a greyish-white colour: that these fibres perform the office of muscles is evident by their contraction and dilatation: in contracting they become shorter, broader, and more opaque on the contracted side of the animalcule, and on the opposite side the antagonist fibres elongate and almost vanish, in consequence of their increased transparency. These facts, and the position of these fibres, as shewn at *m, n, o, p*, of

figures 253 and 258, place beyond a doubt their muscular nature, and that they are the real agents in effecting the motions of the animalcule. The four pair of muscles, *m, n, o, p*, take their origin from the opposite extremities of the animalcule, radiating towards their insertion between the fourth and fifth pair of nervous twigs; *m* indicating the dorsal pair, *n* and *o* the two lateral pairs, and *p* the ventrical pair: these, with the muscles of the forked tail, the seventeen belonging to the rotatory cilia before noticed, form the greater part of the system, and all of them appear to take their insertion from the inner membrane of the envelope, and to be unconnected with the surrounding integuments.

The nervous ganglion is situated near the rotatory muscles, towards the dorsal side of the manducatory organ *b*, it consists of a cluster of glandular bodies, *i*, distinguishable by their greater opacity, and connected by a dorsal vessel, *h h*, which traverses the entire length of the animalcule: from this longitudinal vessel proceed at nearly equal distances nine pair of twigs, which appear at first view to encircle the body, but when carefully examined are found to terminate near the inferior side; they are more slender than the dorsal vessel, and like it, of a whiter hue than the other integuments: these, in the opinion of Dr. E., constitute the nervous system, and strongly resemble that of the *Ascidia*, so beautifully demonstrated by M. Savigney. That these filaments and ganglia are not muscles, is evident from their form, their mode of insertion, and

their not being shortened in the contractions of the animal, but assuming a serpentine form, being apparently passive. That they are not vessels is also evident, because no pulsation or circulating fluid has ever been perceived in them ; hence, by fair reasoning, we may safely conclude they form a nervous system ; and it is well remarked by Mr. Johnston*, that according to all our ideas of known physiological laws, the existence of active voluntary motion presupposes the necessity of an animating nervous system. Hitherto, however, no attempt has been made to prove its existence : but as these animalcules are excluded, by the delicacy and minuteness of their forms, from the ordinary means of investigation, still the transparency of their tissues has enabled us to discover a muscular system in them, and has led to the more than probable notion that there exists also its necessary appendage, a nervous one.

Having in the descriptions of the preceding genera and species shewn the singular and varied methods by which their production is maintained,—such as their propagating by a division of the animalcule, when arrived at maturity ; by buds from the parent, like plants, as in the *Vorticella convallaria*, in some states of its existence ; and by spawn, as in the *Kolpoda cucullus*,—we now arrive at a being which may be said more closely to resemble the higher orders in the animal kingdom. This animalcule is an hermaphrodite (*ff*), the ovarium being united

* Edinburgh Philosophical Journal.

with the lower extremity of the alimentary canal, with (*t t*), two elongated bodies resembling the milt of a fish, which Dr. E. denominates *testes*, and with a muscular changeable body (*g*).

When this creature is about to deposit its eggs, it attaches itself as usual by the tail to the sides of the glass or other vessel in which it is kept, and near to the surface of the water. The eggs are of an oval figure, and twenty or thirty are usually seen in a cluster, though they are produced separately: they vary in size from 1-1000th to 1-200th of an inch, and are of a brown colour, with different degrees of opacity. In the darker eggs no trace of motion can be perceived, but in the lighter the embryo is often seen to move vigorously, and the rotatory cilia of the young are distinctly observed vibrating within the shell.

396. *VORTICELLA rotatoria* (*Rotifer vulgaris*, Shrank and E.—*Furcularia rediviva*, Lamarck.)—*The common wheel Animalcule*.—This curious creature, the astonishment and delight of all its observers, has been already described in the “Microscopic Cabinet,” chapter VI., where two plates, besides wood-engravings, are employed in its illustration; yet the beauty and complexity of its structure incline me to make some few additional remarks, although I must refer the reader to the above for more general information. In the specimens drawn in plates 5 and 6, and at page 65, of the “Cabinet,” some portion of its internal structure is undefined, in consequence of the colouring of the creature.

I have also, by the aid of a superior Achromatic Microscope, satisfied myself of the existence and situation of the eyes; it will therefore be desirable to give a drawing of it, with some details of the parts, in order to render the account more explicit. Figure 255 represents the common wheel animalcule with the wheels withdrawn, and the body *contracted*; the ciliated mouth furnished with a cleft proboscis, or hook-shaped projection, which the creature elevates or depresses at pleasure: this part, however, is better shewn at figure 251, which gives the upper part of the same animalcule in its elongated form. Near the proboscis may be distinguished two small round spots, which, if the microscope be of large angular aperture, and free from aberration, appear of a bright transparent red colour, if not of a dark brown, owing to the want of light: these are the visual organs, and behind them may be detected the two rotatory organs folded within the body, the form of which constitutes one of the principal features between this and the succeeding species. By attentive observation, the manner in which they are folded and spread out may be seen: (see figure 252, which exhibits the muscular fibres, &c.) This sketch I made from an animalcule, which, at short intervals, repeated the operation of folding and unfolding these organs without altering its situation, thus affording me a good opportunity to view it. Near the wheels on the inferior side of the body is the sexual organ, as shewn in figure 251; and below this, the heart-shaped body, or bulbous œsophagus, which, from its lateral motion and the trans-

parency of the intervening integuments, appears to have an opening at the side, but which in reality is not the case. This manducatory organ, through which the food passes, has at its commencement on each side three indentations or teeth: Dr. Ehrenberg only mentions two. From this emanates the long narrow alimentary canal, which is rendered more distinct when the animalcule is fed on indigo, but which in its ordinary condition, when filled with pellucid matter, is not so perceptible. The termination of this canal becoming enlarged, forms the cloaca. When the animalcule stretches itself, the canal is nearly straight; but when contracted, it is serpentine, as in figure 255; and the large eggs arranged on either side of it lay closer together: nine may be counted in the figure.

The tail has considerable muscular play, and is furnished with three pair of forked prongs, two only of which are usually observed, the third pair being for attachment. Although this animalcule is produced from the egg, yet sometimes it is deposited by the parent alive: moreover, the eyes, and the action of its bulbous œsophagus, may be seen while it is within the egg.

From the great length of the insertion of the muscles of the body, it is enabled to contract itself more than the *V. senta*, and to form itself into a globular mass: this is its usual shape when it dies, or when the water evaporates; for it will remain in this form for some time, and afterwards revive. But as this peculiarity has been disputed, the following account of an experiment made by me of this nature may be interesting.

On the morning of the 24th of December, I selected some very fine specimens of these creatures, and having laid them on the stage-glass of a microscope, I covered them with a thin plate of mica : at the end of two hours they appeared lively, but when examined four hours afterwards, all the water being evaporated, no signs of life could be detected, even under a powerful Achromatic Microscope : in this state they were left until the evening of the following day, when, upon being re-examined, they had shrunk, and were apparently quite dead. I then supplied them with a drop of water, and in a few minutes their bodies began to extend themselves upwards : their tails, which were not perceptible before, became protruded, and they began to elongate and contract themselves repeatedly, increasing at each succeeding action until they had recovered the perfect freedom of their muscles, and at last, when the use of their rotatory organs was restored, they swam away. The time taken up in their resuscitation was about ten minutes, but those possessing ova required a longer period. It is remarked that in the young produced from ova, the manducatory and rotatory organs first exhibit signs of vitality : in the case of resuscitation, these organs revive the last. Size, 1-30th to 1-400th.

397. *VORTICELLA erythrophthalma* (*Philodina*, E.) — This creature has not been described by any writer except Dr. Ehrenberg, who enumerates three species, under the generic name *Philodina*, from their love of whirling. The one under notice, the *red-eyed Philodina*, is shown

at figure 254, in the act of whirling, as indicated by the four currents. It has two rotatory organs; hence it belongs to the family *Zygotrocha*, like the preceding, with which it is usually confounded*: they differ mainly in the position of the eyes, which, in the instance before us, are situated below the sexual organs, while in the *V. rotatoria*, figure 255, they are near the end of the proboscis. Dr. E. found several species of this new genus in the vicinity of Berlin, among the confervæ in their Zoological gardens.

The drawing, figure 254, represents the animalcule while lying on its back; it shews the mouth aperture at the centre of the currents; the wheels, eyes, manducatory organs, and the ova, very distinct; and a part also of the narrow alimentary canal, which is represented of a darker colour, as filled with opaque food: the cloaca also is seen near its termination.

Figure 256 is part of a group of eggs; in one of which the bulbous œsophagus of the embryo is visible; in the other the produce has just emerged from the shell, and is half the size of the parent, which is about 1-90th of an inch long.

398. *VORTICELLA najas* (*Eosphora*, E.)—*The three-eyed crystal Vorticella*, represented at figure 257, under ordinary instruments is only distinguishable from the *V. senta* by the body of the former being more cylindrical. When viewed under a superior instrument, with

* See "Microscopic Cabinet," Plate 5.

careful management three red eyes may be discerned ; two of these are situated in front of the rotatory organs, and one behind them, near the bulbous œsophagus. The different parts of the internal structure of this animalcule, by a reference to the drawings of the *senta*, may be readily distinguished, and therefore it is unnecessary to describe them here : we may remark, however, with respect to the insertion of the eight muscles which move the body, that by their being more extended along the middle of the body than in the *senta*, this creature possesses greater powers of contraction. Length, 1-96th of an inch.

399. *VORTICELLA larva*.—This animalcule has not been accurately examined. Müller is the only one who has figured it: it probably belongs to the family *Polytrocha* : the cilia are arranged in the manner of the preceding, and the aperture crescent-shaped. The alimentary canal is large, and surrounded by the ovary, and the tail consists of two short spines, diverging from each other ; this, and the contraction of the different parts of the body, render it easy to be distinguished. Its entire length is about 1-50th of an inch. These are often found with the *senta*, but if kept together in a small vessel, the former soon disappear: their eggs are more globular than those of the latter; and they measure about 1-480th of an inch in diameter.

400. *VORTICELLA succolata* resembles the *V. felis*, except that the head is distinctly marked from the body by an annular contraction.

401. *VORTICELLA aurita*.—This and the three following species belong to the genus *Notommata*, E.: they are furnished with several rotatory organs, arranged equally around the head, which is designated also by a contraction: the tail is forked. Found among *lemna*.

402. *VORTICELLA lacinulata* (*Notommata*, E.)—This creature is sketched at figure 242: it is pellucid, and in swimming moves obliquely. Found in clear water.

403. *VORTICELLA longiseta* (*Notommata*, E.)—*The long bristle-tailed Vorticella*, shewn at figure 267, is an interesting microscopic subject: it is well defined in Book III., and may be readily known by the drawing.

404. *VORTICELLA felis* (*Notommata*, E.)—This animalcule is shewn at figure 265: the cilia are very distinct, and the bicaudal process stout.

405. *VORTICELLA tremula*.—These appear, from the figures of Müller, to belong to the same family as the last. The alimentary canal is short, and the tail simple: a specimen is shewn, magnified, at figure 263. Found in marine infusions.

406. *VORTICELLA constricta*.—This is shewn at figures 266 and 274: it is found among the *lemna minor* and other aquatic plants.

407. *VORTICELLA togata*.—This animalcule resembles the *V. longiseta*; but that the body is thick and short, and its setaceous tail rather long.

408. *VORTICELLA furcata* was first noticed by Leder-muller, but is not accurately known: it is nearly cylin-

dricul, with the tail forked, and capable of being drawn within the animalcule.

409. *VORTICELLA canicula*.—This diaphanous creature bears some likeness to the *V. senta*, with a slight contraction or neck : the tail is forked, and united by two joints to the body.

410. *VORTICELLA catalus*.—This creature has a small tail ; the body is slightly bent, spotted, and furrowed, with several longitudinal folds ; the rotatory cilia are numerous. Found in stagnant water.

411. *VORTICELLA flosculosa*.—This is a clustering *Rotatoria* : numbers of them may be seen attached to the stems of water-plants, and forming a globular cluster : when separate they swim about, and extend their rotatory organs. Figure 230 represents a cluster, of the real size, attached to a stem of hornwort ; and figure 239 is a single one, magnified.

GENUS XVII.

BRACHIONUS.

THIS genus is composed of animalcules enclosed within, or partially covered by, a shell-like coat. They possess rotatory organs, like the *Vorticella*, and form, in Ehrenberg's arrangement, a parallel order. In some of the species eyes have been distinctly recognized, and on the whole their organization is far more complex than that of many others in the larger classes of animated beings. They strongly resemble the *Entomostracea*, and as subjects for the microscope they are extremely interesting, from their size, and their exquisitely beautiful and elaborate structure: it is on this account that I have introduced a sketch of each species.

412. *BRACHIONUS striatus*. *The striped-shell Animalcule*, is shewn, magnified, at figures 261 and 262; the first giving an under view, with the rotatory organs withdrawn, and the last a view of the upper side, shewing the disposition of the cilia. The pellucid shell which covers the back is fluted longitudinally, deflected laterally, enclosing the sides of the body, (see figure 261,) and its superior extremity is formed into six indentations. The body of this creature is of a pale citron colour when it is

in good health, and the bulbous œsophagus, alimentary canal, &c. may be readily discerned, as also the two pair of horn-like processes on the under side. In cases of danger it retires within the shell, having great muscular contractibility. Found in sea water.

413. *BRACHIONUS squamula*.—This creature is covered by a thin, transparent, crustaceous shield, nearly circular, the fore part being, however, indented, as shewn at figure 270; it has no caudal appendage. Found among *lemna*. Size, 1-60th of an inch.

414. *BRACHIONUS pala* (*Anuraca*, Bory and E.)—The shell of this animalcule is of an oval figure, with four long processes in front, which are not readily seen when the creature thrusts out its double rotatory organs. Dr. E. has recognized in it a single eye: it has no tail, and the ova are attached to the body, near to the posterior extremity of the shell, as shewn in figure 269, which is an under view: figure 268 is a back view, with the cilia withdrawn. Found among *confervæ*. Size, 1-90th of an inch.

415. *BRACHIONUS bipalium*. *The pick-axe Animalcule* is shewn, magnified, at figure 271; it is longer than the preceding, and appears to have a double series of indentations.

416. *BRACHIONUS clypeatus* is shewn at figure 282. The upper end of the shell has only one indentation. Found in sea water.

417. *BRACHIONUS lamellaris* (*Stephanops*, E.) is sketched at figure 275. The shell extends beyond the body, and is indentated at its lower extremity; it has two

eyes, and a bifid tail. It is very graceful in its movements. Found among confervæ.

418. *BRACHIONUS patella*, M. and E. *The deep-dish Animalcule* is exhibited at figures 272 and 273; its shell is very convex, and indented at both extremities. The head and trunk are marked by a contraction or neck, and the tail, which is jointed, terminates with two bristles: by these it can attach itself to any substance, and move its small rotatory organs in any direction. Length, 1-100th of an inch.

419. *BRACHIONUS patina* (*Pterodina*, E.) *The round shallow-dish Animalcule* is furnished with two distinct rotatory organs; hence it is placed in the family *Zygotrocha*: two eyes have been recognized. The shell, which is very pellucid, and of a circular form, with a slight indentation in front, is attached to the creature by the middle of its concave surface. Its body is of a bright crystal-like appearance, and the two conical rotatory organs at the mouth can be withdrawn at pleasure. The bulbous œsophagus, alimentary canal, &c. may be very distinctly recognized. Dr. E. states that the tail is forked. In the specimen from which I made the sketch, figure 284, it appeared to me simple. Figure 285 is an under view, magnified. Size, 1-50th of an inch. Found in summer among confervæ.

420. *BRACHIONUS bractea* (*Squamella bractea*, E.—*S. linulina*, Bory.) This creature has a polytrochal rotatory organ, with very delicate cilia, four eyes, and a bifid tail, above which are two spines. When the head is con-

tracted, the concavity of the anterior extremity of the shell may be seen: figure 283 shews it extended.

421. *BRACHIONUS plicatilis*. *The folded Brachionus* is shewn at figure 276 with the wheels fully extended; and the two figures, 278 and 279, give the upper part of the same animalcule, with them both partially and entirely contracted. The various parts, with the ova attached to the body, may be readily distinguished in figure 276. Found in sea water.

422. *BRACHIONUS ovalis* (*Lepadella ovalis*, E.—*Mytilina lepidura*, Bory.) *The egg-shaped Brachionus*.—This creature has a very pellucid and strong shell in proportion to its size, surpassing in strength that of the tortoise. Its polytrochal organs and tail can be withdrawn into the shell at pleasure. In figures 280 and 281, which are amplified 380 times, may be observed the current it produces in the ambient water; the form of its golden-yellow œsophagus, its stomach, and large alimentary canal, filled with colouring matter, to distinguish it from the large ova on each side. Length of body, about 1-250th of an inch. Found in running water among healthy confervæ in spring.

423. *BRACHIONUS tripos*. *The three-spined Brachionus* is shewn, magnified, at figure 291. The shell is composed of two pieces united by a suture along the back, as in the *B. mucronatus*. The animalcule is very diaphanous, shewing its bulbous œsophagus and alimentary canal very distinctly, the latter of which is often of a bright orange colour. The end of the shell is

produced into three spines, and between the two anterior ones plays its bifid tail, by which it attaches itself at pleasure to any convenient substance in the vicinity of its food, and produces a current towards its mouth by the action of its rotatory organs. I have usually found it in July among confervæ. Length, 1-80th of an inch: the proportional lengths of the spines and tail vary in different specimens.

424. *BRACHIONUS dentatus*. *The dentated Brachionus* is enclosed in a bivalve shell, with each end indented and formed into two pair of teeth, as shewn at figure 289. This creature is very active and well defended, as it can withdraw itself entirely within its shell: in addition to the rotatory organs for supplying it with food, I have observed it attached to a stem of confervæ, and abrading it with its teeth fixed in the bulbous œsophagus, which, during the operation, oscillates quickly; the rotatory cilia at the same time move rapidly, which makes it highly probable that they perform some part connected with the organs of respiration, as their motion seems altogether unnecessary while the creature is feeding in this manner. The most remarkable part of this animalcule is its bright pink eye attached to the bulb of the manducatory organ, as seen in the sketch. The length of the shell is 1-90th of an inch. Found among confervæ in June.

425. *BRACHIONUS mucronatus* (*Salpina*, M. E.) *The armed Brachionus* is sketched at figure 298, and magni-

fied : it is rather larger than the preceding (see Book III.) Found in running springs in summer.

426. *BRACHIONUS uncinatas* (*Colurus*, E.—*Colurella*, Bory.)—*The hooked Brachionus* is shewn at figure 297, which affords an edge view, magnified. The shell is bivalve, and of an oval form, pointed at the base : this the animalcule can open at pleasure, and thrust out its simple rotatory organ : its tail is jointed, and terminated by two bristles. Length, 1-500th of an inch.

427. *BRACHIONUS cirratus*.—*The rough-shell Animalcule*, shewn at figure 294, is rather larger than the preceding : it is little known. Müller found it in clear water in the spring.

428. *BRACHIONUS passus* is a curious little creature, with two long bristles in front, like the antennæ of an insect : it is shewn at figure 286.

429. *BRACHIONUS quadratus*.—*The square-shelled Animalcule*, shewn at figure 288, has two rotatory organs seen issuing from the apex of the shell, and two spines from the lower corners ; it has no tail.

430. *BRACHIONUS impressus*.—This animalcule, amplified at figure 287, has a double rotatory organ, which it can withdraw : its tail is long and flexible. Found in stagnant water.

431. *BRACHIONUS urceolaris*, (*Brachionus*, E.)—This creature is shewn at figure 296, with its rotatory organs and vibrating cilia thrust out : its entire length is 1-50th of an inch, the shell being about half that measure : this is

very pellucid, and open at both ends, the upper extremity having sharp indentations on one side, and being wavy on the other: the body is affixed to the centre of the shell, being free at both ends to contract or extend itself at pleasure. According to Dr. Ehrenberg, it has a single eye, and is an example of the *Gasterodela* form of the digestive organs. The young are produced from eggs while attached to the parent, in the manner shewn at the figure 296. Some specimens have four or five eggs, and others are without any: as soon as the embryo is matured, the parent breaks the shell by means of its tail, when the young animalcule thrusts out its head and body, and immediately commences whirling. When of sufficient age to defend itself, the parent detaches it from itself, and swims away. (See figures 295 and 299.)

432. *BRACHIONUS Bakeri*.—Mr. Baker's loricated-wheel animalcule is exhibited at figures 292 and 293: the form of the shell is different from that of the preceding, having, besides some very long spines at its anterior extremity, its posterior terminated by a single long one on either side of it, as shewn in the figures. The eggs are sometimes disposed on these long posterior spines; at others, they are attached to the tail. The largest specimen I have seen measured 1-30th of an inch in length.

433. *BRACHIONUS patulus*. *The wide-mouthed Brachionus* is shewn at figures 300 and 301: it is about half the size of the preceding one; very transparent, like crystal, and has the anterior indentations of the shell

uniform. The posterior is concave, and the tail forked. Found with the *Vorticella rotatoria*.

The two following animalcules have been discovered since Müller's time, but cannot be admitted into any of his genera: it may be advisable, therefore, to describe them here, though it is probable they do not strictly belong to this class of animated beings; yet, as their structure is very peculiar, and they are but little known, a short account of them may be interesting: they are figured in Vol. II. of Brewster's Encyclopædia.

434. THE URSLET is a translucent creature, about the size of the wheel animalcule (396.) When viewed sideways, its contour resembles that of the Polar Bear; it has four pair of feet, the last pair occupying the situation of a tail, and all of them are furnished with three sharp claws: it sheds its skin, which is smooth, although the body is wrinkled; a cluster of ova may be observed near the back, which is convex. These were discovered in Germany, and subsequently found in Scotland; but were unknown in England until lately, when Samuel Powell, Esq. found some specimens at the bottom of some clear water, containing lemna and confervæ, obtained from a pond on the Portland Town side of the Regent's Park: a few of these he kindly sent me: they appeared very sluggish and unwieldy, and did not swim, but remained at

the bottom of the vessel on their backs, struggling to turn themselves about. I am inclined to think, however, that they are not scarce, but only difficult to be procured from their residing in the sediment at the bottom of the vessel: it is probable that, in their natural situation, they attach themselves to the water plants, and are dislodged in the act of being collected.

435. THE SLOTH.—This curious animalcule is of a dingy yellow colour, about three times the size of the common wheel animalcule (396), and, like it, is capable of being resuscitated, after becoming dry and apparently dead: the body is cylindrical, with the anterior extremity convex, and the posterior furnished with four feet-like processes, each terminated by a sharp claw. On the under side are three pair of feet, resembling those of a caterpillar, all of which are also furnished with a single bent claw: it never swims, and appears almost incapable of supporting its own weight. Scarce. Found at the bottom of infusions containing the *Vorticella rotatoria*.

BOOK III.

PHYTOZOA*.

CLASSIS I.—*POLYGASTRICA*†.

ANIMALIA evertebrata apoda nonnulla caudata, vasa sanguinifera et systema nerveum nullibi conspicua. Oculorum rudimenta paucis. Os omnibus ciliis vibrantibus coronatum nudumve ventriculis pluribus appendiculatum aut canali alimentario perfecto polygastrico auctum. Pharynx non discretus inermis. Partus. Ovipara (vivipara) et sponte dividua. (Utrum gemmæ sint an ova vocanda interna propagula observationes olim decident.)

A. ANENTERA.

Ore ventriculis pluribus appendiculato ano discreto nullo (tubo intestinali nullo.)

ORDO I. NUDA.

ORDO II. LORICATA.

FAMILIA I. GYMNICA.

Corpore non ciliato ore ciliato nudove.

SECTIO I. MONADINA.

A. Pullis internis nunquam conspicuis, corpore in binas aut quaternas partes sponte dividuo.

a. Cauda nulla.

1. pellucida.

MONAS, vide 1, 2, 7, 8, 11 to 21.

2. obscura.

DOXOCOCCUS, vide 28.

436. — inæqualis, 1-2400th.

437. — pulvisculus, 1-1400th.

b. Caudata.

BODO, vide 3 to 6.

? UROCENTRUM, 181.

B. Pullis internis conspicuis.

* Remarks, see page 192.

ORDO I. NUDA.

ORDO II. LORICATA.

FAMILIA III. PSEUDOPODIA. Familia I.

Corpore proteo processibus pediformibus variabili.

SECTIO V. AMŒBÆA.

SECTIO I. BACILLARIA.

AMŒBA, *vide* 22 and 24.

Cum lorica dividua.

BACILLARIA, *vide* page 59.

SECTIO II. ARCELLINA.

Lorica non dividua.

a. Lorica urceolata.

450. DIFFLUGIA proterformis,
1-600th.

————— acuminata.

b. Lorica scutellata.

ARCELLA, *vide* 236.

451. ——— dentata.

452 ——— aculeata.

B. ENTERODELA.

Tubo intestinali perfecto (ore anoque terminato) polygastrico.

FAMILIA IV. ANOPISTHIA. Familia II.

Ore anoque contiguus in eadem fovea.

SECTIO VI. VORTICELLINA.

SECTIO III. OPHRYDINA.

A. Corpore pedicellato, pedicello filiformi nudo (nec vaginato) sæpe ramoso.

A. Corpore nudo pedicellato, pedicello filiformi vaginato.

a. Pedicello in spiram contractili.

a. In spiram contractili.

VORTICELLA, *vide* 354, 355.

CARCHESIUM, *vide* 371, 372.

EPISTYLIS, *vide* 373, 374.

OPHRYDIUM, *vide* 367.

B. Corporis pedicello nullo.

C. Corpore vagina membranacea incluso.

a. Ciliorum corona simplici.

a. Non pedicellato.

TRICHODINA, *vide* 230.

454. VAGINICOLA crystallina.

b. Ciliorum corona duplici.

455. ——— tincta.

453. STENTOR polymorphus.

456. ——— decumbens.

557. ——— socialis.

b. Pedicellato.

TINTINNUS.

FAMILIA V. ENANTIOTRETA.

Ore anoque oppositis terminalibus.

SECTIO VII. ENCHELIA.

A. Ore transverse truncato.

a. Corpore non ciliato.

ORDO I. NUDA.

ORDO II. LORICATA.

ENCHELYS, *vide* 51 and 70.

b. Corpore ciliato.

458. COLEPS hirtus.

459. ——— elongatus.

c. Corpore setoso.

ACTINOPHRYS, *vide* 235.

B. Ore obliquo (sæpe ciliato.)

a. Corpore non ciliato.

1. In collum capitatum non extensili.

TRICHODA, *vide* 163.

460. ——— paramaecium, 1-1080.

? BURSARIA.

2. In collum capitatum extensili.

LACRYMARIA, *vide* 115.

b. Corpore ciliato.

LEUCOPHRYS, *vide* 58 and 229.

561. ——— pyriformis.

FAMILIA VI. ALLOTRETA. Familia III.

Ore anove terminali.

SECTIO VIII. TRACHELINA.

SECTIO IV. ASPIDISCINA.

A. Ore inermi infero.

ASPIDISCA, *vide* 306.

a. Labio superiore prælongo, subæquali colli formam referente.

TRACHELIUS, *vide* 414, 149, 269, 278.

b. Labio superiore brevi dilatato obliquo.

LOXODES, *vide* 151, 160, 161.

B. Ore uncino suffulto (infero.)

GLAUCOMA, *vide* 133.

FAMILIA VII. KATOTRETA. Familia IV.

Nec ore, nec ano terminali.

SECTIO IX. KOLPODEA.

SECTIO V. EUFLOTA.

A. Proboscide brevi inermi.

EUFLOEA, *vide* 307.

a. Corpore partim ciliato.

KOLPODA, *vide* 159, 162.

b. Corpore ubique ciliato turgido.

ORDO I. NUDA.

ORDO II. LORICATA.

PARAMAECIUM, *vide* 142, 143.

B. Proboscide nulla.

AMPHILEPTUS, *vide* 117, 157.SECTIO X. OXYTRICHINA. Sc-
tosa aut uncinosa.

a. Uncinis stylisque nullis.

OXYTRICHA, *vide* 291, 328, 333.

462. ——— pellionella.

b. Uncini; styli nulli.

KERONA, *vide* 321.

c. Styli; uncini nulli.

UROSTYLA, *vide* 255.

d. Uncini, stylique.

STYLONYCHIA, *vide* 327, 329.CLASSIS II.—*ROTATORIA*†.

Animalia evertebrata radiata apoda sæpe caudata, ciliis peculiaribus rotantia.

Ganglia nervea pharyngea plura (cur non cerebalia?), annulus nerveus nuchalis et nervus abdominalis in majoribus conspicua. Sæpissime oculi pigmento læte rubro. Canalis alimentarius distinctus simplex; ventriculi species nonnullis appendices cæcæ apud alia. Pharynx sæpius maxillis armatus, nonnunquam dentigeris. Vas dorsale immobile (reticulatum) ramosum. Succus corporis pellucidi. Hermaphrodita. Ovipara et vivipara, nec sponte dividua.

ORDO I. NUDA.

ORDO II. LORICATA.

FAMILIA I. *MONOTROCHA*†.

Ciliorum corona simplici integra.

SECTIO I. ICHTHYDINA.

SECTIO I. STEPHANOPINA.

A. Cæca.

A. Cæca.

a. Dorsio glabro.

a. Cauda simplici.

ICHTHYDIUM, *vide* 182.464. *MONURA* colurus.

b. Dorsio setosa

b. Cauda furcata.

CHÆTONOTUS, *vide* 313.465. *COLURUS*, *vide* 426.

463. ——— brevis.

466. ——— bicuspidatus.

B. Oculis duobus.

STEPHANOPS, *vide* 417.

ORDO I. NUDA.

ORDO II. LORICATA.

FAMILIA II. SCHIZOTROCHA.

Ciliorum corona simplici laciniatim constricta variabili.

SECTIO II. MEGALOTROCHÆA.

A. Oculo unico.

467. *MICROCODON clavus*.

B. Oculis quatuor.

468. *MAGALOTROCHA alba*.

SECTIO II. FLOSCULARIA.

A. Cæca.

a. Gelatina corpus involvente.

1. Organo rotatoria bilobo et subquadrilobo.

464. *LACINULARIA socialis*.

2. Organo rotat. multifido.

FLOSCULARIA ornata.

Ciliis longissimis eleganter ornata.

*b. Vagina corporis membranacea.**MELICERTA ringens*.

FAMILIA III. POLYTROCHA.

Ciliorum coronulis pluribus.

SECTIO III. HYDATINA.

A. Cæca.

a. Simplicia.

1. Maxillæ dentatæ.

HYDATINA, vide 395.

——— -- gibba.

2. Maxillæ inermes.

† Ore recto terminali.

ENTEROPLEA lacustris.

† Ore obliquo infero.

*PLEUROTROCHA petromyzon.**b. Composita.**ZOOBOTRYON pellucidus.*

B. Oculo unico.

*a. Frontali.**FURCULARIA gibba.*

——— gracilis.

b. Dorsali.

1. Cauda setacea nec furcata.

MONOCERCA, vide 315.

——— bicornis.

2. Cauda simpliciter furcata.

† Ciliis rotatoriis æqualibus.

SECTIO III. EUCHLANIDOTA.

A. Cæca.

LEPADELLA, vide 422.

B. Oculo unico.

a. Lorica depressa.

1. Cauda simplici.

MONOSTYLA, vide 319.

——— quadridentata.

2. Cauda furcata.

EUCHLANIS macrura.

——— dilatata.

b. Lorica turgida aut angulosa.

1. Cauda simplici.

ORDO II. NUDA.

NOTOMMATA, *vide* 402, 403, 404.

————— æqualis.

————— saccigera.

————— decipiens.

————— forcipata.

†† Ciliis rotatoriis inæqualibus
partim longioribus setaceis
tentaculiformibus.

SCARIDIUM, *vide* 320.

3. Cauda bis furcata.

DINOCHARIS, *vide* 318.

————— detractis.

————— paupera.

C. Oculis binis, aut bis acervatis.

a. Frontalibus simplicibus.

DIGLENA, *vide* 198.

————— capitata.

————— aurita.

b. Dorsalibus simplicibus.

1. Cauda simplici.

RATTULUS, *vide* 313.

2. Cauda furcata.

DISTEMMA, *vide* 201.

————— forficula.

————— setigerum.

c. Dorsalibus acervatis.

THEORUS vernalis.

D. Oculis tribus.

a. Uno dorsali, duobus fronta-
libus.EOSPHORA, *vide* 398.

b. Tribus dorsalibus.

NOROPS dorsalis.

E. Oculis pluribus in circulum dis-
positis.CYCLOGLENA, *vide* 199.

ORDO II. LORICATA.

MASTIGOCERCA carinata.

2. Cauda furcata.

SALPINA, *vide* 425.

———— spinigera.

———— ventralis.

———— redunca.

———— brevispina.

c. Oculis duo.

METOPIDA triptera.

D. Oculis quatuor.

SQUAMELLA, *vide* 420.

FAMILIA IV. ZYGOTROCHA.

Ciliorum coronulis binis.

SECTIO IV. PHILODINÆA.

A. Cæca.

CALLIDINA elegans.

SECTIO IV. BRACHIONÆA.

A. Cæca.

? NOTEUS, *vide* 432.

ORDO I. NUDA.

B. Oculis duobus.

a. Frontalibus (ante organa rotatoria).

1. Cauda ter furcata.

ROTIFER, *vide* 396.

———— tardigradus.

———— macrurus.

2. Caudæ quinque apicibus.

ACTINURUS neptunius.

b. Dorsalibus (pone org. rot.)

1. Cauda simpliciter furcata.

MONOLABIS conica.

2. Cauda ter furcata.

PHILODINA, *vide* 397.

———— aculeata.

———— citrina.

ORDO II. LORICATA,

B. Oculo unico.

a. Cauda nulla.

ANURÆA palea.

b. Cauda furcata.

BRACHIONUS, *vide* 431.

c. Oculis duobus.

PTERODINA, *vide* 419.

REMARKS UPON BOOK III.

(*) PHYTOZOA.—This term was first made use of by Goldfuss, and is confined, in the preceding Table of Dr. Ehrenberg, to those microscopic creatures whose digestive organs are polygastric, or, if they possess a simple alimentary canal, it is always accompanied by rotatory organs; hence the eels in paste (see 125), and some other of the Infusoria not having the latter organs, are rejected.

They are divided into two orders, distinguishable by the covering of their bodies; the one having a membranous envelope, called *nuda*; the other, a delicate horny or shell-like coat, termed *loricata*. In the Table it will be observed there are none of the latter order until we arrive at the *Pseudopodia*, Dr. Ehrenberg not having admitted any but those whose alimentary structure he had demonstrated, although it would appear, from

a recent paper of his*, that he had now filled up this vacancy. I would remark also, that in his original table, the *Monads* are the only genus admitted by him into the first family: the others which I have inserted are from Dr. Ehrenberg's notes.

(†) POLYGASTRICA.—The animalcules included in this class are the most numerous. They are separated into two grand divisions: the *Anentreta*, in which the digestive sacs are not attached to an alimentary canal, but are connected all of them with the oral cavity, their only channel of communication; the *Enterodela*, in which the sacs are connected to a tubular membrane, or alimentary canal, which latter assumes three forms: the first, and simplest, is that shewn at fig. 41, called *Orthocoela*, and is nearly straight. The second, the *Campylocoela*, in which it takes a serpentine course, as shewn in figure 159. The third, the *Cyclocoela*, in which the form is nearly circular, returning into itself, as in the *Convallaria citrina*; (see figure 202.)

In several of the Polygastrica, eye-like spots have been discerned, as in the genera *Euglena*, *Amblyophis*, and *Distigma*, which would induce the belief of the existence of a nervous system. These eyes clearly shew that the Microscope is really improved of late, as they were not seen in any of the old construction: this is borne out by that excellent paper of Dr. Grant's, in Vol. X. of Brewster's Edinburgh Journal, where he has given a very correct description of the *Cercaria* (see 183), but has not observed its bright orange brown eye, so distinctly seen in an Aplanatic Engiscope.

(‡) ROTATORIA.—The alimentary structure of this highly-organized class is separated into four kinds. The

* Berlin Trans. 1832, abstracted in the Edin. Phil. Journ. Vol. XV.

first, *Trachelogastrica*, is that in which the creature is destitute of manducatory instruments, and possesses a very long œsophagus, and a simple alimentary canal: this form is illustrated in the *Ichthydium* (see 182), *Chaetonotus maximus*, and the *Enteroplea*. The second kind is the *Cologastrica*, which Dr. Ehrenberg exemplifies by the *Euchlanis macrura*, and the *Synchaeta tremula*: these are furnished with masticating organs, and have a short œsophagus and simple large alimentary canal. The third Dr. Ehrenberg calls *Gasterodela*: they are in all respects like the preceding, except that their alimentary canal is formed by a constriction into two portions—the anterior or gastric, and the posterior or proper alimentary canal, as in the *Enteroplea hydatina*, *Diglena lacustris*, *Magalotrocha alba*, and in § 419, 431, and 414. The fourth kind, termed *Trachelocystica*, and illustrated by the *Vorticella rotatoria* (395), and *Philodina roseala*, have a long, narrow, alimentary canal, surrounded by a cellular apparatus: they have also a pharynx and cloacal enlargement.

In a Supplementary Treatise it is purposed to give a more enlarged systematic arrangement of the PHYTOZOA, according to their organization, together with the result of such further observations as the Author shall make, or be favoured with,—the design of the present work not admitting it here.

THE END.

*Prices of the Optical Instruments described in the
“ Microscopic Illustrations” and the “ Micro-
scopic Cabinet.”*

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